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Joint Effects of Communication Mode and Consensus on Virtual Team Decision Quality

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JOINT EFFECTS OF COMMUNICATION MODE AND CONSENSUS ON VIRTUAL TEAM DECISION QUALITY

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A Dissertation

Submitted in Partial Fulfillment of the Requirements for the
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DISSERTATION APPROVAL

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AN ABSTRACT OF THE DISSERTATION OF

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TITLE: JOINT EFFECTS OF COMMUNICATION MODE AND CONSENSUS ON VIRTUAL TEAM DECISION QUALITY

MAJOR PROFESSOR: Dr. C. Keith Waugh

The purpose of this research study is to expand upon the body of knowledge and research regarding the conditions and processes for effective decision-making in virtual team environments. Specifically, this study sought to demonstrate that teams instructed in consensus produce higher quality decisions and attain the assembly effect (synergy) on complex decision tasks. In addition, teams in virtual communication environments will produce higher quality decisions and attain the assembly effect (synergistic decisions) less often than face-to-face teams on complex decision tasks.

Mostly undergraduate students from business courses (N = 358) completed the NASA Survival Exercise complex decision task first individually, then as teams. Subjects were randomly assigned to teams; teams were randomly assigned to one of two decision mode conditions: i) instructed in the consensus decision technique; and ii) not-instructed in the consensus decision technique. Subjects were then randomly assigned to one of three communication mode environments: i) face-to-face; ii) instant messaging; and iii) videoconferencing.

A 2 X 3 between-subjects factorial design was used to examine the research questions. The hypotheses compared several mean decision performance measures for three and four-person teams (n = 105) differing in decision mode (consensus instructed vs. not-instructed) and differing in communication mode (face-to-face) or one of two virtual communication environments (instant messaging or videoconferencing). Hypotheses for the decision mode main effect, the communication mode main effect and the interaction effect were not statistically significant. However, the decision performance measure means for communication mode and the interaction between communication mode and the decision mode were in the predicted direction. Future research is needed to clarify the influence of consensus instruction and technology-mediated communication environments on virtual teams.

Keywords: assembly effect, synergy, decision-making, decision quality, consensus, computer-mediated communication, technology-medicated communication, virtual teams, NASA Survival Exercise, complex decision tasks

DEDICATION

This is dedicated to my wife, children and grandparents who sacrificed in many ways over the years to make this possibility a reality. To my wife, Suzanne, you inspired me through your example, encouraged me with your words, enlightened me with your knowledge, supported me through your dedication, and lifted me up with your love. Thank you for helping me to make my dreams reality! To my two beautiful daughters, Julia and Sophia, you have taught me more about the meaning of life and given me more happiness than I will ever be able to share or give in return. Thank you for being patient with me and always managing to fill my heart with joy! To my grandparents, Aloysius and Emma Michels, you were always there when I needed you. You took a troubled boy into your home and loved him as your own. Thank you for providing me an environment to grow and dream; I will always remember you!

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER ONE – INTRODUCTION

Since the early 1990s, a new global economic system has expanded business operations and service/product offerings to virtually every corner of the earth. This trend of globalization has lead to an immense pressure on organizations worldwide to look to new technologies and new management techniques to remain competitive.

One management technique that has been employed to increase competitiveness in nearly every business with over 100 employees has been to move organizations from work systems designed around individual contributors to group-based (team) structures (Cohen & Bailey, 1997). It is widely believed that teams can produce decisions of higher quality than decisions produced by an individual working in isolation (Hill, 1982). In a 1993 survey of Fortune 1000 companies (which is made-up of multi-national publicly traded business), 91% of the companies reported using work teams, and 68% were using self-managed teams (Lawler, Mohrman, & Ledford, 1998).

By 2000, the dynamic use of business teams started to shift from collocated teams to teams made of individuals who were located in many geographic locations. With increased globalization and multinational corporate structures becoming the norm, the majority of large organizations were not only using work teams, but virtual teams as well. Virtual teams have become an integral part of organizations because of an increase in corporate restructuring, competition, and globalization (Baker, 2002). A growing number of organizations are implementing virtual teams or plan to implement them in the near future (McDonough, Kahn, & Barczak, 2001) and their use is expected to continue to grow (Carmel & Agarwal, 2001).

The remainder of this section is dedicated to issues that need to continue to be addressed by future research in team decision-making, team decision quality and effective group communication, and the appropriate use of teams, more specifically virtual teams to perform increasingly complex work in a global economic environment.

Use of Teams/Virtual Teams in a Rapidly Changing Work Environment

Competition in the global marketplace has caused businesses to search for new operational efficiencies and improvements. Continued market expansion and competitive pressure, the rapid infusion of technology, the changing nature of work, and social reforms have forced organizations to adopt new organizational design approaches. For businesses to remain competitive, they must reduce costs, improve quality, improve customer service, and be able to change strategies and processes to swiftly adapt to an increasingly competitive marketplace (Levi, 2001).

Not only are U.S.-based businesses able to compete and offer products or services worldwide, but businesses operating in some of the most remote places in the world can also compete with and offer their products and/or services here in the U.S. It is because of this immense economic shift that many organizations have felt pressured to employ individuals from many countries with lower labor costs than in the U.S. This practice has led to organizational structures that employ workers in many countries at the same time. Often times these workers also need to collaborate and work together as teams or virtual teams to address corporate needs.

Additionally, the nature of work has shifted from the specific and routine to a complex non-routine work environment (Mohrman, Cohen, & Mohrman, 1995). Workers, regardless of their level, are faced with complex projects, problems and decisions that require diverse knowledge, skills, and abilities that are best suited for teams. Levi (2001) noted that few individuals have all the necessary knowledge and expertise required in the new complex work environments of today; therefore, the team approach is needed to address the complex environments and confusing issues which exist in the work environment of today.

New and different operational methods are being used to improve productivity and quality that require employees from all departments within a company or workers from many organizations to work together. The complexity of jobs, organizational structures, and the economic environment force organizations to address business challenges with new strategic policies, which often times include team-based work environments. As problems become more complex, and the solutions require active input from diverse perspectives, then teamwork and virtual teamwork becomes increasingly necessary and valued. LaFasto and Larson (2001) also believed that teamwork was being made more possible by the increasing social capacities of workers to use collaborative and team-based strategies when dealing with problems.

Multi-national organizations are becoming increasingly dependent on teams and team-based organizational strategies and cultures to remain competitive. In fact, a 2002 survey by the Gartner group found that more than 60% of professional employees worked in virtual teams (Kanawattanachai & Yoo, 2002). For American companies to remain competitive in the global economy, more research related to improving the effectiveness of teams, specifically virtual teams is warranted. To maximize team effectiveness, organizations must adapt their human resources systems to accommodate the unique need of virtual teams. HR systems that are affected include recruitment, selection, training and development, performance appraisals, and compensation and reward systems. However, to date, few publications have systematically evaluated the impact of team-based systems on organizational HR practices (Salas, 2003).

Purpose of the Study

The purpose of this study was to build upon and contribute to the knowledge of the established body of research on small groups—specifically, small group communication processes, virtual (technology mediated) communication in teams, and the quality of group decisions. This study sought to support past research findings that found consensus instruction effective in facilitating team communication processes, increasing decision quality, leading to the assembly effect (synergy). Additionally, this research sought to determine if differing virtual communication environments affect a team's ability to increase decision quality and ultimately attain the assembly effect.

Considerable research exists on the quality of team decision-making as compared to the quality of individual decision-making. It is this difference in quality of the group's performance versus the quality of the group's best individual member's performance that has directed much research on group decision-making, more specifically group decision quality, since Collins and Guetzkow (1964) first termed this difference as the "assembly effect". Group research that has attempted to produce the assembly effect has had mixed success (Steiner, 1972), and at times groups have even performed worse than the group's best individual member. Why then were some studies successful in producing the assembly effect and others not?

A review of the literature revealed that studies that successfully produced the assembly effect have a common group decision process, known as consensus (Devine, Clayton, Philips, Dunford, & Melner, 1999; Nemiroff & King, 1975; Waugh, 1996). To summarize, according to the previous research, if the following conditions exist, then the assembly effect (synergy) will occur: (a) all group members contribute their available resources to the group; (b) the interaction process is facilitating; (c) pooled information is integrated into the group decision; (d) the group is working on a complex task; and (e) the group uses consensus-seeking decision techniques.

Based on previous research, groups instructed in consensus building decision techniques can obtain higher quality decisions. When the group's functional communication process is improved through the introduction of consensus instruction, the group should have improved decisions (higher quality decisions) and/or improved team outputs. However, how does the nature of the task affect the group's ability to use its group member's resources? Are certain complex task types more conducive to effective team communication and the ability of the team to obtain the assembly effect? How does the task type interact with decision mode techniques such as consensus? Additionally, what is the effect in virtual environments where information is suppressed and important communication cues aren't present, or are lost (Daft & Lengel, 1984)? Is consensus training enough to combat information suppression in virtual environments? Answers to these questions, and other practical questions like them are needed in future team research to deal with the realities of the virtual team decision-making environment that exists in the world of business today.

Statement of the Problem

The issue addressed in this study was to determine what decision methodologies and communication modes improve or inhibit the performance (decision quality) of decision-making teams beyond its most capable member. Can making teams aware of consensus building techniques positively influence their performance? Do differing virtual communication modes (instant messaging or videoconferencing) affect group performance?

Currently, much research exists that has measured the quality of group decisions. Some of this research has focused on the decision-making processes that are often used by teams. This research has generally found that groups that use consensus seeking in the decision-making process typically produce higher quality decisions, as measured by the assembly effect (Stapleton, 2006; Waugh, 1996) than groups that do not use consensus seeking in the decision-making process, and also produce higher quality decisions than individuals working independently (Hare, Blumberg, Davies, & Kent, 1994).

A large amount of research exists that focuses on computer-mediated communication in team environments. However, this research tends to focus on individual perceptions and preferences of differing computer-mediated communication modes; individual's confidence or satisfaction with group members or the decision process; how differing computer-mediated communication modes can affect the group's chances of reaching consensus; or the amount of time required for the group to make a decision (Martins, Gilson, & Maynard, 2004). Some of this research does focus on group decision quality, but little virtual team communication research was found that used the assembly affect as a measure of group decision quality or combined the effects of consensus instruction and differing virtual communication modes on group decision quality.

Research Questions

Based on previous research results and the arguments previously provided, combined with the fact that this research attempts to replicate past research, the following three research questions are investigated in this study:

RQ_1: Does consensus instruction impact team decision quality?

RQ_2: Does type of virtual technology-mediated communication used affect team decision quality?

RQ_3: Does the effect of consensus instruction on team decision quality depend on the type of virtual communication mode used?

Significance of the Problem

Global economic issues, the complexity of work and significant advances in technology have combined to change the nature of work from individual-based to team-based work environments. In fact, virtual work is becoming as common as face-to-face work (Morello, 2005).

A study by Cohen and Baily (1997) found that nearly 85% of companies with more than 100 employees used work teams. Because a large portion of decision-making in organizations is done in a dynamic and asynchronous environment using email and other information technologies (Dasgupta, 2003), this research has value for the vast majority of organizations that use these technological tools in team-based and virtual team-based work environments daily to address their complex business issues. Additionally, this research is significant to human resource and training professionals whose purpose is to assist organizations and their employees with improving the performance and decision quality of decision-making teams, and whom are under increasing pressure to justify their expenditures with a return on investment. According to the WorkUSA 2000 report, U.S. organizations were spending nearly $80 billion annually for employee training and development (Pfau, 2002).

Most large organizations are using teams to solve the many complex issues that so permeate the workplace of today. A recent Gartner report predicted that by 2008 virtual workgroups consisting of internal and contract workers would comprise 60% of work arrangements (M. A. Bell, 2005). Many corporate teams are composed of members who are geographically dispersed; therefore, many of these teams are dependent on virtual communication technologies to assist the team members in effectively communicating ideas and/or making decisions. For virtual teams that rarely meet face-to-face, communication technologies are vital for collaboration (Hollingshead, 2004).

With success or failure of an organization possibly riding on the quality of the decisions that are made by these teams, empirical research is needed that addresses not only the quality of team decision-making, but how virtual communication modes affect the team decision-making process and ultimately the quality of the team's decision.

An estimated $3.92 billion dollars will be invested on internet-mediated communication technologies by organizations worldwide in 2010 (Pettey, 2010). Combined with the over 50 billion dollars invested on group training and converting work systems into team-based structures (Paradise & Patel, 2009), businesses must show a return on their investments in these IT systems, training and team-based management strategies if they are to remain competitive in today's globalized economy.

Limitations and Delimitations

Limitations

There are several potential limitations to this study. First, one potential limitation deals with the issue that all participants in the study first completed the complex decision task individually, then completed the complex decision task with their group. Therefore, it is impossible to control for possible learning or practice effects on the team's performance even though past research which has used the NASA decision task in a repeated measures design has not shown that individuals improved on the decision task (Burleson, Levine, & Samter, 1984).

Second, even though the NASA decision task has been used many times in small-group decision research (Hall & Watson, 1971; Innami, 1994; Waugh, 1996), any decision task such as this cannot be considered representative of all the problems and decisions typically encountered by work teams in organizational environments.

Third, this research cannot attempt to control for all possible confounding variables that are commonly found in small group research. Variables such as motivation, interpersonal relationships, power, influence, team trust, team cohesion and cognitive or personality trait differences were not controlled for in the study design because these variables were beyond the scope of this experimental study. It is expected that randomly assigning individuals to the task teams randomly distributes these variables among the teams and will have a similar effect on the differing research conditions.

Fourth, the population used consists mainly of undergraduate business students; this population cannot be considered representative of the entire working population. Lastly, this research was conducted in an experimental laboratory environment. Based on the limitations of the empirical experimental laboratory environment used to gather this research, caution should be used when generalizing these results to the "real world" of working teams.

Delimitations

Part of the purpose of this study was to combine lines of research, small group decision research, information systems research, management research and virtual team research to build upon past research to better understand possible interaction effects on a decision-making team's ability to improve decision quality and achieve the assembly effect. Additionally, the design of this study allows for the interpretation of the results obtained by comparing the current research results to results obtained in previous studies.

To determine the validity of consensus training on team decision-making for the six experimental conditions, it was deemed necessary to replicate some of the procedures and treatments of past studies. Specifically, the use of the NASA decision task which was created and extensively used by Hall (1971; Hall & Williams, 1966, 1970), by Yetton and Bottger (1982), and again by Waugh (1996); the use of a college student population (Kandell, 1992; Nemiroff & King, 1975; Waugh, 1996); the use of a face-to-face communication condition (Branson, Clausen, & Sung, 2008; Nemiroff & King, 1975; Waugh, 1996); and the use of small task groups consisting of three or four members (Martins, et al., 2004).

Additionally, the fact that the research design only allows the virtual teams to use one communication mode during the completion of the decision task, when in fact most teams use multiple communication modes when making decisions (Dasgupta, 2003), restricts the applicability of the results. Finally, the choice to measure decision quality and the assembly effect using the indexes and procedures previously used in similar research allows for direct comparison to past research results, but limits result generalization.

CHAPTER TWO – REVIEW OF THE LITERATURE

Introduction

Why are groups so important? Why study groups? It is not in human nature to live or work alone. Humans are social creatures with an inherent social nature. The group is the oldest and most common of all social organizations (Fisher, 1974). In fact, human society is a collection of groups and often individuals belong to many groups of friends, groups of associates at work, recreational groups, etc. With every human belonging to at least one group, it is not surprising that an extremely large body of research exists looking at groups and group behavior.

Because humans spend so much time in groups, it is natural to question group effectiveness. Is it better to do things alone or work with a team? The answer depends upon how well the team works together, how focused it is, and how much creative and critical thinking the team allows. Additionally, how well does the group weigh information, how effectively does it create options, and how critically does the group evaluate ideas? Obviously, groups vary in their ability to do these things well; this paper examines what the prevailing research in the fields of social psychology, communication theory, management theory and information technology research have contributed to the knowledge regarding small group decision-making.

This chapter is a review of the relevant literature that is necessary to develop adequate theoretical and empirical evidence in support of the purpose and need for this study. The review will focus on the development of a team-based work environment, small group decision-making research, the concept of the assembly effect, computer-mediated communication technologies research and virtual team research as it applies to team decision-making and decision quality.

Terminology and Definitions

Communication Terms and Definitions

While the term computer-mediated communication has been used widely in team and communication research, the definition is not completely clear. Computer-mediated communication is usually defined as any communicative transaction that occurs using two or more networked computers. While the term has traditionally referred to those communications that occur via text (e.g., instant messages, e-mails, chat rooms), it has also been applied to other forms of text-based interaction such as text messaging which occurs over telecommunications networks (Thurlow, Lengel, & Tomic, 2004). Text communication can be asynchronous (communication that occurs at different times) such as email, or synchronous (real-time communication) such as instant messaging. For the purposes of this study, instant messaging is defined as a private internet chat environment that allows the team members to interact via real-time text messaging with the entire team.

Recently, the term Internet-mediated communication has been used in technology-based team communication research. Internet-mediated communication includes any communication that occurs over the internet such as computer-mediated text communication and richer communication environments such as audio and videoconferencing. The term Internet-mediated communication has been used to describe common internet communication tools such as Skype and social networking communication sites such as Facebook™, Linkedin™ and Twitter™. For this study, videoconferencing is defined as a private internet audio/video environment that allows all team members to see and hear each team member at the same time.

Technology-mediated communication is another term that has been used in recent technology-based communication research. Technology-mediated communication can be defined as all communication that is mediated by technology (not just computers, includes cell phones, etc.) that is asynchronous and synchronous, interactive and not interactive.

Communication research has also referred to technology-based communication as “virtual”, especially when referring to organizational work teams. Virtual communication environments refer to a wide range of technologies that assist work teams to complete their work.

For the purposes of this experimental research, the above communication terms are used interchangeably, except when referring to past research. When describing past research, an attempt has been made to use the terminology originally used in that research by the author(s).

Group, Team and Virtual Team Definitions

There exists a fair amount of research that does not attempt to make a distinction between groups and teams. Sundstrom, DeMeuse, and Futrell (1990) believed that a work group or a work team is an interdependent collection of individuals who share responsibility for specific outcomes for their respective organization. In fact, much of the literature on small groups has used the terms group and team synonymously (Guzzo & Dickson, 1996). Devine and Philips’ (2001) review of the literature found that few empirical reports described the study context well enough to make fine distinctions between groups and teams. While distinctions could be made between groups and teams related to research focus (Kerr & Tindale, 2004), the distinction was artificial rather than reflecting true differences in research focus or objective.

On the other side of the fence, some researchers are careful to make clear distinctions between groups and teams. Katzenbach and Smith (1999) used size as a way of distinguishing between groups and teams. Groups range in size from two to thousands, while teams are usually made up of a smaller number of individuals usually ranging from two to 20. Levi (2001) used interaction as a point of distinction. He explained that integration in work groups is limited to completing the same task and group members have limited interaction. Whereas, work teams share performance goals and accountability, plus group members have direct interaction with each other even though this interaction may not occur face-to-face. Robbins (2005) used purpose of interaction combined with expected outcome as the distinguishable factor between groups and teams. Work groups interact primarily to share information and to make decisions, while a work team generates positive synergy, or an increased level of performance beyond the sum of the individual inputs through coordinated effort.

Although there is some debate in the literature, for the purposes of this exploration, the terms group and team are used interchangeably. A team/group will be defined as a collection of individuals from an organization whom are brought together for a specific purpose, or to perform a specific task. As with the communication terms, when describing past research, an attempt has been made to use the terminology originally used in that research by the author(s).

Many corporate teams today are at times required to communicate and make decisions using technology-mediated communication. Actually, most corporate teams today work together in some level of virtualness, and all teams (even face-to-face teams) use technology to communicate and make decisions (Griffith, Sawyer, & Neale, 2003). However, virtual teams are distinguished by their preponderance, and at times exclusive reliance on IT to communicate with each other (Powell, Piccoli, & Ives, 2004). For the purposes of this study, a virtual team is defined as a team whose members use technology to work across a locational boundary to accomplish a task. In this study, the "virtual teams" communicated exclusively through either the instant messaging or videoconferencing technology-mediated communication environment to complete the task.

Evolution of the Work Environment

During the early 1900s, management principles focused on how work should be organized and controlled (Proctor, 2005). Even though team-based work was rare during this time (Wesner, 1996), significant evolutions in management thought, theory, and practice would lay the foundation for the use of team-based work environments and the current management practices of today.

The Evolution to Self-Directed Work Teams

As noted by Wesner (1996), there were three major influences on the nature of work during the first half of the 20th Century. The first influence was *Scientific Management*. The second influence was the *Human Relations Movement*. The third influence was *Group Dynamics*.

Scientific management.

The theory of scientific management, also referred to as Taylorism, is closely associated with Frederick Taylor (H. A. Robbins & Finley, 2000). The scientific management movement began in the early 1900s in an attempt to create methods to improve production and efficiency in factories.

Taylor (1947) based scientific management on the belief that man deliberately does as little as he safely can. He believed that workers reduced their productivity in an effort to maintain job security and protect their specialized knowledge. In order to overcome this, Nelson (1980) noted that Taylor designed scientific management to shift control away from the workers to a centralized production planning system controlled by upper management. Opponents of scientific management did not concur with the humanistic view of it. Often employees and unions disliked scientific management criticizing its emphasis on output for compensation as an attempt to bribe and manipulate workers (Grenier, 1988). Taylor's scientific method did cause a lot of controversy and debate, but did have a significant impact upon the industrial workplace (Nelson, 1980).

Human relations movement.

In response to the fact that the scientific method was not increasing worker productivity in many organizations, scientists and researchers began to question the appropriateness of Taylorism (Levi, 2001). Organizations began to consider whether individual behaviors could be improved by altering work conditions and focusing on the social aspects of work. The most notable experiment was the Hawthorne Studies conducted at the Western Electric's Hawthorne Works location from 1923 to 1932 (Wesner, 1996). Much like scientific management, human relations studies focused on improving management control of worker productivity. The Hawthorne study began in 1923 studying the effects of varying degrees of illumination on worker productivity. The intent was to identify environmental factors that could improve worker productivity. Both the experiment and the control groups showed increased productivity regardless of the lighting conditions, which puzzled the researchers (Hersey & Blanchard, 1977). Further, Hawthorne studies manipulating other environment variables produced similarly puzzling results. Roethlisberger (1977) concluded that improved performance was tied to the better treatment of workers by management and that worker satisfaction was closely tied to worker performance.

Group dynamics.

The Hawthorne studies and the work of the early human relationists defined the small group as a critical aspect of the workplace (Wesner, 1996). It moved management's focus from the individual to that of the small group and an interest in determining which methods could attract groups of workers to support organizational strategies. Building upon this new management focus, Kurt Lewin, a German psychologist who was interested in scientific management, wrote about the role that psychology of workers might play in solving management conflict.

Social Interactions

During the 1950s and 1960s, two main forces continued to shape the work environment and improve employee productivity. The first was the development of the mainframe computer (Robbins & Finley, 2000). This allowed companies to perform complex accounting and financial tasks. Second, the work of Elton Mayo and Kurt Lewin led to rapid growth in the area of training and development. Increased understanding of the impacts of group dynamics on individual worker behavior led to a variety of training programs designed to improve the social interactions and interpersonal skills of managers and supervisors (Wesner, 1996). Wesner noted that it was during this time that the term “team” began to be used almost interchangeably with the term “group” to describe groups in the workplace.

Employee motivation and satisfaction.

Many disagreed with the group dynamics approach to improving employee performance. For Example, Herzberg, Mausner, and Snyderman (1959) rejected the human relations or group approach to improving productivity claiming that it shifted supervisors’ focus from business results and goals of production to the needs of subordinates. Herzberg’s theory of motivation led to the understanding that work itself, if designed correctly, could serve as a powerful motivator (Perrow, 1973).

McGregor (1967) conducted a number of studies intended to identify whether or not successful managers required natural abilities or whether they could be trained. He identified the perception of managers towards people and work as key determinants of successful management behavior. Theory X managers assume that people disliked work, tried to avoid it and would need to be controlled to maintain productivity. Theory Y managers assume that people are self-directed and will seek to achieve and accept responsibility.

Training and development.

Building on the interest created by Lewin and Mayo, a whole industry emerged based upon the idea that managers could be trained to lead workers to greater performance (Perrow, 1973). By the 1950s, human relations training became a major part of supervisory and management training (Serbein, 1961). It was believed during the human relations era that most problems in the workplace were caused by the lack of relationship skills of supervisors. The focus of human relations training was to change the behavior of supervisors and managers to improve motivation and performance of individual workers (Wesner, 1996).

During the 1960s, training shifted to laboratory training, also referred to as sensitivity training, t-groups, and encounter groups training (Argyris, 1963). Laboratory training allowed individuals opportunities to see their behavior and receive feedback on developing a self awareness of behaviors that may cause conflict in the workplace. Many of the laboratory training sessions shifted from the individual to a focus on the group and laid the foundation for organizational development theory.

Organizational development.

Burke and Greenglass (1987) cited Robert Blake's work in sensitivity training sessions at an Esso refinery in the late 1950s as the birthplace of Organizational Development (OD). The training was broader than traditional human relations and sensitivity training and focused on developing and implementing organization-wide training interventions to problem solving-based training. Team building, the process of developing and training teams, was an example of one such OD intervention. While the development and training of teams during this period was nearly universal, one characteristic that distinguished it from today's practices was that most training teams were made-up of managers (Wesner, 1996).

Global competition.

The increased global competition faced by American companies in the 1970s, along with the dramatic expansion of markets, caused companies throughout the world to change the ways they operated so as to reduce costs and increase quality (Levi, 2001). As globalization brought on more and more competitive pressure, companies began to focus on team initiatives to improve quality and improve organizational efficiencies. The focus on social interaction since the 1950s continued, as organizations sought to satisfy and motivate employees by involving all types of workers to be a part of collaborative work teams focused on improving the work environment and organizational effectiveness.

The quality movement.

Heightened interest in the 1970s in participative management, worker satisfaction, and the potential for improved productivity brought about experimentation of new operational methods that involved workers in decisions affecting their jobs. Quality Circles (QC's) created unprecedented growth of teams in the American workplace (Wesner, 1996). In the late 1970s and early 1980s, QC's began to be used by American companies attempting to improve their competitiveness by increasing quality and lowering costs (Cohen & Bailey, 1997). In spite of mixed results, companies continued to utilize teamwork in the form of quality circles and total quality management as a new way to organize workers. Most jobs were still designed for and performed by individuals (Levi, 2001), but workers were organized into teams as a way to improve quality and other aspects of production.

Increased complexity of work.

Many factors have sustained the use of teams and the quality movement: (a) The increased use of and dependence on information technology, (b) downsizing and decreasing levels of management, (c) business process reengineering, (d) self-managed work environments, and (e) globalization. These factors have all led to the increased use of teams in the work environment. In 2000, organizations everywhere, of every size, saw teams as part of the answer to issues of strategic focus, cost containment, restructuring, productivity and training (Robbins & Finley, 2000). In fact, Robbins and Finley noted that teams and the use of team concepts are at least partially responsible for the long period of economic expansion enjoyed in the 1990s.

Communication and computer technology.

Many advances in technology have had a profound effect on the workplace. More often than not, advances in communication and computer technology have changed the nature of work, and how individuals work together. The computer, the Internet, and communication programs (such as e-mail, instant messaging and texting) have had a dramatic impact on the nature of communication at work since the late 1990s.

Advances in computer and communication technologies made it possible for U.S. organizations to compete and offer their products or services virtually worldwide. Advances in computer and communication technologies combined with the ever decreasing cost of these technologies have allowed for a more geographically dispersed workforce that challenges the traditional notion of the workplace (Solomon, 2001). Because individual team members can often be located in different buildings, different cities, different regions, and in different countries, Internet-mediated technologies are often used to assist work groups in completing their tasks (Dasgupta, 2003).

Summary of Evolution to Work Teams

Organizations will increasingly move from work systems designed around individual contributors to team-based structures in which two or more individuals work interdependently to accomplish organizational goals. The advantages of teams are manifold: task redundancy; synergy from combining efforts; availability of great cognitive resources to deal with technological and environmental complexity; workload leveling; continuity in the face of turnover; greater coordination across functions, departments, and divisions; and allowing for the decentralization of decision-making.

The idea of teams is likely to continue to expand as organizations become more complex due to trends toward market concentration, continued technological advances, decentralized decision-making, and the growth of new jobs that are designed specifically for team-based organizational environments (Stapleton, 2005). The need for continued experimental and applied research related to the effectiveness of team and virtual team decision-making is critical to the continued success of American companies and the U.S. economy.

Small Group Research

There are four main bodies of research provide researchers with most of their understanding of groups and teams. First, there is a large body of research in psychology and the social sciences that examines how people work in small groups, which is referred to as the study of group dynamics. Group dynamics research has been conducted for over 100 years and provides researchers and business practitioners with the broad foundation of knowledge that forms the basic understanding of group operations. There is also an extremely diverse assemblage of research related to groups under the discipline of communications. Second, communications research spans from the study of the first human languages and writings to contemporary scientific research on interpersonal and group communication. Third, the research area of information technology has looked at group interactions in computer-mediated environments and often looked at and compared these teams to face-to-face teams. Finally, over the past three decades, the last main body of research stems from applied social scientists, managers and business strategists who have studied the use of teams and more recently virtual teams in the workplace and how these teams can improve organizational effectiveness.

With the rapid increase of the use of teams in the work environment over the past several decades, an emphasis has been placed on how to make teams work more effectively. It is this emphasis on team effectiveness that will be a major focus of this papers' exploration and the theoretical foundation for this author's planned study of research.

Group Dynamics Research

For about a century, psychology and the social sciences have examined how people work in small groups (group dynamics). Kurt Lewin is generally credited as being the founder of the study of group dynamics (Levi, 2001). Lewin was an early 20th century psychologist who was instrumental in establishing group dynamics as a field of study.

One of his most well-known series of studies was conducted at the Harwood Manufacturing plant in Marion, Virginia. Management at the Harwood plant was concerned about the plant's productivity and invited Lewin to assist in 1939. This began an eight-year collaboration in which Lewin suggested, and helped implement, many approaches to solving Harwood's productivity issues.

As reported by Marrow (1969), Lewin recommended that management deal with their productivity issues by dealing with workers in small groups, and demonstrating to the groups of employees that they were capable of meeting management's set production levels. Early results increased productivity. Lewin believed that groups of individuals were more likely to maintain behavioral changes because of the support of the group (Levi, 2001). Lewin continued implementing new team-based work ideas such as allowing workers to participate in setting goals, controlling output levels, developing solutions to production problems and allowing workers to participate in production and management planning meetings. All of these changes resulted in continued increases to production at the Harwood plant.

Even though the validity of the Harwood plant studies has come into question (Gomberg, 1966), the Harwood studies supplied a plentiful source of data on the behavior of workers in groups and created a new research discipline, Group Dynamics (Marrow, 1969).

Small Group Decision-Making

The main approach to team research and theory development over the past several decades has followed the input-process-output (IPO) model frequently attributed to Hackman and Morris (1975). This approach suggests that team "process" mediates the relationship between team inputs (knowledge) and outputs (decisions). Process, which is responsible for converting inputs into outputs, was originally conceptualized as "all the observable interpersonal behavior" (Hackman & Morris, 1976, p. 49) that exists within the work group over a period of time. For the purposes of this exploration and the proposed research, the focus will solely be on observable written and verbal communication.

The IPO model approach to measure team effectiveness has received much empirical support. Despite the fact that a number of researchers have expanded and/or modified this conceptual model of team effectiveness, current opinion is that the basic model still holds true and is a useful way of approaching team theory and research (Sacco, 2002).

As summarized by Stasser and Dietz-Uhler (2001), the social psychological empirical research on small group decision-making falls loosely into three categories. The early work tended to focus on group versus individual comparisons, followed by a second phase of research focusing on more sophisticated questions about how individual responses are (or should be) combined to yield a group response (Steiner, 1972). The most current phase has focused more directly on the social influence, cognitive, and communications processes that shape and reshape individual responses into what ultimately is the group's response or decision.

Three meta-theoretical perspectives have shaped the most recent phase of empirical small group decision-making research (Stasser & Dietz-Uhler, 2001). The social combination perspective views group interaction as a means of combining individual responses to yield a group response. The social influence perspective views group interactions as being guided by social influences, which modifies and consolidates individual responses within the overarching social pressure of group consensus. The social cognitive perspective shifts to cognitive activities of the group members, individually and collectively as a group. Larson and Christensen (1993) argued that it is useful to reference group-level cognitive activities the same way they occur at the individual level: acquisition, storage, transmission, manipulation, and use of information to produce a group level product or decision. Much of the rest of this section will focus on ways to better understand the "process" that groups' use to make decisions.

Small Group Decision Quality

It is a common belief in Western society that groups make better decisions than individuals, as exhibited by the phrase "Two heads are better than one". Does this mean that when individuals are given the chance to communicate their knowledge and information with others within a group, a better decision outcome is possible? Businesses seem to think so. It is widely believed by businesses, and supported by years of research, that work teams improve both efficiency and quality in the workplace (Levi, 2001). It would appear that better decision outcomes for groups are not only a possibility, but are often expected.

Cattell (1948) was the first to use the term synergy to describe group effort. If group effort is a kind of energy, some of this energy goes into solving task obstacles, and some goes into dealing with interpersonal ones. The amount of energy devoted to interpersonal hassles is called intrinsic synergy, and the remaining energy available for the task is effective synergy. If effective synergy is high, the task will be accomplished effectively; if not, it will be done poorly.

Following on Bales' (1953) interaction process analysis work and Cattell's work, Collins and Guetzkow's (1964) group decision-making model showed that a task group is confronted with two types of problems—task and interpersonal obstacles. Task obstacles are the difficulties encountered by the group in tackling its assignment. Interpersonal obstacles come out of how well group members get along with, and work effectively together. When task and interpersonal work is integrated effectively, an assembly effect (synergy) occurs in which the group solution or product is superior to the individual work of the best member.

Much has been written about how to quantitatively determine whether teams outperform individuals. How do researchers define which decision outcomes are of higher quality than other decisions? Collins and Guetzkow (1964) hypothesized that small groups, when working on certain kinds of projects, could perform at a level beyond the capabilities of even their best individual. They referred to this phenomenon as an assembly effect, often-called synergy in the business world. Collins and Guetzkow defined the assembly effect as "when a group is able to achieve collectively something which could not have been achieved by any member working alone or by a combination of individual efforts" (p. 58).

Small Group Communication Theory

Human Communication Theory

Craig (1999) said that communication is the primary process by which human life is experienced; communication constitutes reality. Craig wrote that all communication theories are ultimately practical because every theory is a response to some aspect of communication encountered in everyday life.

The cybernetic, sociopsychological and sociocultural communication traditions have contributed much to the study of groups and group decision-making. Under the cybernetic tradition, communication is understood as a system of parts, or variables, that influence one another, shape and control the character of the overall system, and, like any organism, work to achieve balance and change. The *sociopsychological* tradition has had a powerful impact on communication research and focuses on the study of the individual. The *sociocultural* approach to communication theory addresses the ways our understandings, meanings, norms, roles, and rules are worked out interactively in communication. The sociocultural approach is based on the idea that reality is not an objective set of arrangements outside us, but is constructed through a process of interaction in groups, communities, and cultures.

Traditionally, the communication discipline has been divided along five lines of communication levels or contexts: (a) interpersonal, (b) group, (c) public, (d) organizational, and (e) mass communication (Littlejohn & Foss, 2005). Interpersonal communication and group communication levels are the central contexts of interest to small group decision-making. Interpersonal communication deals with communication between people, usually in face-to-face private settings. Group communication relates to the interaction of people in small groups, usually in decision-making groups.

Powers (1995) created a model that imagines the work of the communication field in four context categories or tiers. The categories are summarized as follows: (a) The content and form of the messages, (b) Communicators as individuals, participants in social relationships or as members of cultural communities, (c) Levels of communication, including public, small group, or interpersonal, and (d) Contexts and situations in which communication occurs. For the purposes of this research, the focus was on the level of communication (small group or interpersonal) and the context of the communication (face-to-face or virtual).

Small Group Communication Theory

As mentioned previously, a large amount of communication theory and research has been directed towards a better understanding of groups and how individuals communicate within, and as part of a group. Much of this research has complemented and intertwined with the research that has been explored in the disciplines of psychology, sociology and other social sciences.

Bales' (1950) Interaction Process Analysis theory is a classic sociopsychological, group dynamics-based group communication theory. Bales created a unified theory of small-group communication, aiming to explain the types of messages that people exchange in groups, the ways in which these shape the roles and personalities of group members, and thereby the ways they affect the overall group communication process.

Groups are often viewed as cybernetic systems in which information and influence come into the group (input), the group processes this information, and the results circulate back out to affect others (output). Collectively, this idea is known as the input-process-output model (IPO Model). This basic idea about groups has influenced how researchers look at groups, and most of the research has followed this model. Researchers have looked at the factors that affect the group (input), the happenings within the group (process), and the results (output).

Using Craig's (1999) metamodel for organizing communication theory, it appears that the IPO Model credited to Hackman and Morris (1975) comes from the sociopsychological tradition and cybernetic tradition. The Functional Theory of group effectiveness builds upon the sociopsychological tradition by applying cybernetic and sociocultural traditions to a deeper understanding of the “process” component of the IPO Model, more specifically the group’s task or set of tasks.

The Functional Theory is classified as a sociocultural theory because it focuses on the social construction of teams and groups. In other words, groups or teams are often formed for a purpose. This purpose often directs the team’s structure and its processes. The Functional Theory is rooted in the work of Dewey’s (1910) pragmatic ontological six-step process to problem solving. The Functional Theory of Group Communication builds on Dewey’s work and centers on the process by which groups make decisions. An epistemological tenet exists that there is a connection between the quality of group communication and the quality of the group’s outputs (Gouran, Hirokawa, Julian, & Leatham, 1993). The Functional Theory makes an axiological value claim that higher group output is desirable, and attempts to enact change in group behavior by defining effective group communications and effective group processes which lead to higher quality group outputs.

Hirokawa’s functional theory.

Hirokawa (1982) is viewed by his peers as a leader of the functional tradition of the group decision-making process. His work looks at a variety of mistakes that groups can make, aiming to identify the kinds of things groups need to take into consideration to become more effective. Hirokawa’s (1982) functional views build upon Benne and Sheats’ (1948) essay concerning the functional roles that group members can play during group discussions. Beene and Sheats were the first to make distinctions between the task and maintenance functions of group activity.

Hirokawa and Scheerhorn (1986) developed a general model of the group decision-making process that depicted the general sequence of group problem solving interaction. First, the group normally begins by identifying and assessing the problem. Next, the group gathers and evaluates information about the problem. Next, the group generates a variety of alternative proposals for handling the problem. Finally, the alternatives or objectives are evaluated, with the ultimate goal of reaching consensus on a course of action.

The factors contributing to faulty group decisions are easily inferred from the decision-making process. The first is improper assessment of the problem. The second source of error in decision-making is the group identifying inappropriate goals and objectives. The third problem is improper assessment of positive and negative decision qualities. Fourth, the group may develop an inadequate information base.

Why do groups fall into these traps? Hirokawa (1988) believed that the errors most often arise from the communication process in the group. Hirokawa conducted a study of four aspects of decision quality: appropriate understanding of the problem, appropriate understanding of the objectives and standards of a good decision, appropriate assessment of the positive qualities of alternatives, and appropriate assessment of the negative qualities of alternatives. Statistical analysis showed that the quality of a group's decision is related to the four elements; and, when the best groups were compared to the worst, there was a significant difference in the extent to which the group accomplished each function.

Interestingly, the definition of systems used by the cybernetic tradition is very similar to how Collins and Guetzkow (1964) defined the assembly effect (synergy) in team environments. Systems are defined as sets of interacting components that together form something more than the sum of the parts. Systems also take inputs from the environment, process these inputs, and create outputs into the environment. The same is true of teams, and is inherent in the topology of the Input-Process-Output (IPO) model and the Functional Theory's perspective of team communication effectiveness.

The current trend in small group theory is interested in the group's effectiveness, as the functionalist tradition illustrates. Hirokawa's functional theory provides guidelines for improved group functioning. The guidelines suggest ways of guarding against various hazards of groups. Consistent with the everyday experience of groups in society, such theories have practical potential in helping organizations to train individuals to be more effective in team environments.

The Team Communication Process

Groups encounter many communication problems when trying to make decisions (DiSalvo, Nikkel, & Monroe, 1989). Group decisions require skillful facilitation and can get bogged down in emotional conflicts that waste time and decrease morale. Group discussions can lose focus or be interrupted, and dominant members can control the direction of the group. These issues can cause significant team inefficiencies that lead to ineffective team decision making. This inefficient behavior by teams was termed process loss by Steiner (1972). Process loss leads to the team's inability to reach its full productivity potential, irrespective of whether it outperforms the group's best member.

Hirokawa (1982) realized that past group communication research only identified four common types of group communication functions: (a) Group establishes a set of operating procedures; (b) Group understands and analyzes problem, (c) Group generates feasible alternative solutions, and (d) Group evaluates each alternative before deciding on a final solution. He also noted that past research was not applied directly toward group decision-making or problem solving effectiveness, but rather on the group communication process itself. Finally, he noted that past research did not make provisions allowing for segregation of “relevant” from “irrelevant” group task behaviors.

Hirokawa (1982) argued that it was imperative that new research “operationalize the group interaction process in terms of those communicative utterances which perform functions essential for effective group decision-making and problem-solving” (p. 137). Hirokawa’s Functional Theory on the small group communication process has been widely debated and widely applied to the field of small group research. As noted by Pavitt (1994), and Cragan and Wright (1990), the functional perspective represents one of the dominant theoretical influences on the study of communication in decision-making and problem-solving groups.

Group and Communication Research and its Implications

In general, groups do appear to produce both more and better decisions than the average individual (Hill, 1982). However, in spite of years of research and practice, at least half of the teams and team initiatives seem to be failures (Beyerlein, McGee, Klein, Nemiro, & Broedling, 2003). Moreover, in many cases, teams produce decisions of less quality than what would be expected considering the knowledge, skills, and abilities of the group’s members. Therefore, the benefit of this trend to use team-based work systems in organizations to make decisions rather than using work systems based on individual contributors to make decisions is not yet substantiated by the research or by business practice.

Group Decision Quality and the Assembly Effect

Watson (1928) is credited as the first person to conduct small group research that demonstrated that small groups outperformed individuals on a word building test. Much research has supported Watson's initial findings and has showed that groups in general perform significantly better than individuals on tasks (Hill, 1982; Johnson, Maruyama, Johnson, Nelson, & Skon, 1981; Miner, 1984; Smith, 1989).

Collins and Guetzkow (1964) defined the "assembly effect" as "productivity which exceeds the potential of the most capable member and also exceeds the sum of the efforts of the group members working separately" (p. 58). According to Collins and Guetzkow, the potential to achieve the assembly effect is present in any group. However, the realization of this potential is dependent on the ability of the group members to build effective communications. Many studies have attempted to replicate Collins and Guetzkow's assembly effect and have been conducted in an effort to identify the team member compositions, communication processes, and task types leading to improved team performance and ultimately the assembly effect.

A meta analysis conducted by Johnson, Maruyama, Johnson, Nelson and Skon (1981) of small group performance research showed that "cooperative groups" (groups whose members deliberate and come to a consensus for each answer) are considerably more effective than "competitive groups" (groups whose members' goals conflict, or when "majority rule" is used to form group decisions). Generally speaking, groups perform superior on decision-making tasks to individuals, when the group uses "consensus-seeking" decision techniques.

The research also demonstrates the superiority of group decision-making over that of individual performance for complex, conjunctive tasks (Johnson & Johnson, 1987). Hill (1982) reviewed the small group decision research and concluded that two conditions seem necessary for groups to achieve the assembly effect when solving difficult, complex problems. First, the group must pool the different and unique pieces of information that the individuals bring to the decision task to produce a decision of high quality. Second, the group must integrate the pooled inputs into the group's solution. Therefore, the process by which groups integrate individual member input to arrive at a group decision is an important characteristic of group performance and is discussed in the next section.

Achieving the Assembly Effect

How do businesses insure teams reach their potential? Much research has been devoted to minimizing process loss and determining what conditions need to exist to ensure groups obtain the assembly effect or synergistic results (Innami, 1994; Nemiroff & King, 1975; Stapleton, 2006; Waugh, 1996). Many researchers do believe that groups provide quantitative and qualitative improvements to work otherwise completed by individuals. A review of the literature by Johnson and Johnson (1987) found that a large body of research that compared the effectiveness of individual and group decision-making had been conducted and the overwhelming conclusion was that groups made better decisions than individuals.

Levi (2001) wrote that studies showed that production work teams improved both efficiency and quality. He also pointed out that when teams were utilized, the entire organization improved performance because employees accepted decisions and were more likely to follow through to successfully implement agreed upon solutions.

Robbins and Finley (2000) offered a long list of advantages of teams. They believed that organizations should choose teams over individuals. They showed that teams saved money, increased productivity, improved communication, did work that ordinary work groups could not do, made better use of resources, produced better-quality goods and services, improved processes, and made higher-quality decisions.

The question of whether teams outperform individuals is an issue that is likely to continue to be researched because of the increased utilization of teams and virtual teams in organizational environments (Branson, et al., 2008). Additional research is needed to develop an increased understanding of the processes necessary to guide teams to their maximum potential. Although work is commonly organized around teams, there is relatively little empirical research on the interaction between team technology-mediated communication, and consensus training in team-based settings. As practitioners continue to apply new concepts derived from research, more teams will minimize process loss, reach higher productivity potential and attain the assembly effect.

Group Communication and Decision Quality

Steiner (1972) identified three determinants of individual or group productivity: task demands, resources, and process. Task demands include the requirements imposed on the individual or group by the task itself or by the rules by which the task is performed. Resources include knowledge, abilities, skills, and tools needed to perform the task. Process consists of the steps and actions taken by an individual or group to integrate resources and task demands to perform the task. For Steiner, potential productivity or maximum productivity of an individual or a group is determined by matching of resources and task demands. Potential productivity is the summation of the individual's available resources. For maximum potential to be reached by a group, the individuals in the group must be willing to contribute their resources to the task demands. If actual productivity is less than potential productivity, this constitutes "process loss". If actual productivity is greater than potential productivity (the summation of the individual resources), this is defined by Hackman and Morris (1976) as "process gain". The process gain concept is very similar to the assembly effect concept introduced by Collins and Guetzkow (1964).

It would seem that process loss, process gain or the assembly effect takes place depending on the outcomes of the interaction process between the group members. If the interaction process is "inhibitory", then process loss is expected. If the interaction process is "facilitating", then the assembly effect occurs.

Hirokawa (1982) believed that the function-oriented theory of group communication would produce more accurate (and thorough) representations of the contribution of group member behaviors to the group's decision. He argued that his function-oriented system could determine not only what types of utterances were produced, but also how those utterances contributed to the completion of the group task and thus, the quality of the group's decision. Hirokawa has since conducted several research studies which have attempted to test/prove his theory and analysis system (model).

In a very simplistic way, both the IPO model and Harokawa's Functional Perspective can be used to predict group outputs. As mentioned earlier, one of the ways to evaluate group decisions is to determine if the assembly effect occurred or if process loss occurred. A basic tenant of both the IPO Model and the Functional Perspective assumes that improvements that occur in process can and should lead to improved decision-making and ultimately higher quality team decisions.

Teams sometimes do not reach their potential because their internal processes interfere with success (Levi, 2001). Levi noted that many teams choose to adapt an unstructured approach rather than taking a structured approach to problem solving. Especially for interactive teams, the utilization of a decision rule, often referred to as a decision mode, is likely to be better than informally attempting to reach decisions (Hare, et al., 1994).

Autocratic decision modes, such as seniority, authority, or expert, may leave members feeling less than satisfied. In contrast, egalitarian decision modes, such as majority vote, nominal group technique, and consensus make full utilization of each member's input (Forsyth, 1999). In general, decision-making techniques that include group discussion and participation lead to higher quality decisions (Levi, 2001).

Ness and Hoffman (1998) made a strong case for the use of consensus decision making. Consensus decisions are characterized by agreement of most members on a clear decision, and supported by those that had a sufficient opportunity to share opposing alternatives. Additionally, all team members agree to support and implement the consensus decision. The potential benefits of the consensus decision mode are increased quality, stronger and more positive team cultures, and increased accountability and commitment to implement the decision (Ness & Hoffman, 1998).

Conversely, Nemeth and Nemeth-Brown (2003) stated that one of the causes for poor decision-making is the desire for consensus. They argued that the desire for consensus could lead to agreement with the majority view, regardless of whether it is right or wrong. They also believed that attempts to reduce hindrances or obstacles in order to avoid "loss" leads to premature closure and stifles dissent, which is critical to high-functioning team decision making.

Decision mode has significant implications on successful development and utilization of teams in the workplace. If teams are unable to take full advantage of members collective contributions, they will not attain potential productivity levels (Roberto, 2004). Consensus provides an opportunity for input from all members and creates a mechanism to maintain support and cooperation of those with different viewpoints. Researchers must strive to improve group communication processes and decision modes to assist human resource development practitioners with the development and implementation of improved approaches and models to group decision making. The effect of the consensus decision mode on team performance is not clear from the research and is tested again in this study.

Teams and Complex Decision Tasks

McGrath noted (1984) that there had been very little study devoted to the analysis of task differences, in a systematic way that took into account how task differences can affect group task performance. "If tasks really make a difference—and everyone agrees that they do—then it seems worthwhile to devote some of our efforts to analyzing and classifying tasks in ways that relate meaningfully to how groups perform them" (McGrath, 1984, p. 53).

Although concern about task differences had existed in group research for many decades, the first programmatic effort to describe the different characteristics of group tasks in a systematic way was Shaw in the late 1960s (Shaw, 1981). Shaw (1973) outlined six characteristics, or dimensions along which group tasks varied: (a) intellective versus manipulative requirements, (b) task difficulty, (c) intrinsic interest, (d) population familiarity, (e) solution multiplicity versus specificity, and (f) cooperation requirements. The first dimension has to do with the properties of the task. The next three focus on the relations between the task and the group that works on the task. The fifth dimension focuses on how the task is scored, which is the "correctness" of the group answer or decision. The last dimension refers to what group members must do in relation to one another.

Steiner (1972) distinguished between tasks that are divisible and those that are unitary. Unitary tasks are those that have a single outcome or product, while divisible tasks can be divided by members and combined or coordinated to create an outcome. Steiner divided unitary tasks into three types (disjunctive, conjunctive and additive), based on how member contributions are combined to yield the single product. For disjunctive tasks, if any one member can and does solve the problem, the group solves it. For conjunctive tasks, all group members must succeed for the group to be successful. Performance of disjunctive tasks depends on the talent and knowledge of the group's "best" member, while performance on conjunctive tasks depends on the talent and knowledge of the group's "poorest" member. Additive tasks are those where the contributions of group members are combined to create an outcome. Additive tasks depend on the ability of the group's "average" member. Most "natural" tasks (McGrath, 1984) are highly complex divisible tasks, requiring complicated coordination of group members efforts.

McGrath (1984) created the Circumplex Model of Group Task Types classification schema for group task types attempting to unify the previous classification systems into one all encompassing system which eliminated overlaps in classifications. He started by identifying four basic quadrants of task types: (a) generate, (b) choose, (c) negotiate, and (d) execute. Each of the four task types can be measured against two continuums. The horizontal dimension (continuum) reflects a contrast between behavioral and intellectual task types. The vertical dimension (continuum) reflects a contract between cooperative or facilitative and conflict-based task types. Each of the four quadrants is divided into two process subtypes. This leads to the following eight task types each represented in its own quadrant and sub-quadrant and measured against the horizontal and vertical continuums: (a) planning tasks, (b) creativity tasks, (c) intellective tasks, (d) decision-making tasks, (e) cognitive conflict tasks, (f) mixed-motive tasks, (g) contests/battles tasks, and (h) performances tasks.

In general, decision-making techniques that include group discussion and participation lead to higher quality decisions (Levi, 2001). This is especially true if the problems are complex or unstructured or if the leaders do not have enough information to make good decisions. Because complex decisions require the collective wisdom, experiences, and perspectives of the entire team, Ness and Hoffman (1998) believed that consensus was especially required for the toughest decisions and problems.

Hill (1982) reviewed the small group decision research and concluded that two conditions seem necessary for groups to achieve the assembly effect when solving difficult, complex problems. First, the group must pool the different and unique pieces of information that the individuals bring to the decision task to produce a decision of high quality. Second, the group must integrate the pooled inputs into the group's solution. The research also demonstrates the superiority of group decision-making over that of individual performance for complex, conjunctive tasks (Johnson & Johnson, 1987). Therefore, the process by which groups integrate individual member input to arrive at a group decision is an important characteristic of group performance.

It has been recognized that some tasks may not be suited to computer-mediated communication. For example, problem solving tasks are considered unsuitable for computer-mediated environments because they require substantial interaction (Straus, 1996). Baltes, Dickson, Sherman, Bauer and LaGanke (2002), conducted a meta-analysis that summarized the research on computer-mediated groups versus face-to-face groups on decision tasks. They concluded that there is little support to adopt computer-mediated communication as a medium for group decision making. Compared to face-to-face conditions, computer-mediated decision making takes more time, less information is exchanged and the satisfaction of team members is rather low. This study compares the decision quality of face-to-face and computer-mediated groups on a complex decision task to test the validity of the previous research findings.

Summary of Small Group & Group Communication Research

The literature review revealed that studies that have successfully produced the assembly effect have a common group decision process (consensus) and looked at research related to gaining a better understanding of how technology-mediated communication systems affect the group decision-making process and ultimately the group's ability to obtain the assembly effect.

The review of the small group research in the area of group decision process identifies the importance of the use of consensus decision techniques to maximize group performance on group decision tasks. It appears that consensus decision techniques are integral to a group's ability to integrate and utilize group member inputs to achieve the assembly effect. Therefore, groups that employ consensus decision techniques are more likely to achieve the assembly effect.

Past small group decision research has demonstrated that effective communication is critical to the consensual decision-making process as supported by the functional communication theory and the IPO model. Research has also focused on task type and the appropriateness of certain types of tasks for teams and virtual teams. From the literature, it appears that teams can be quite effective at dealing with complex problems and tasks, but it also appears evident that complex tasks seem to present more problems for teams that communicate in virtual environments. The next section of this review will look more closely at why this is.

Computer Mediated and Virtual Team Research

The study of communication usually starts with the study of language, but language goes beyond the words that are used. To make meaning of language and to effectively interpret messages, individuals must use many other cues. These cues include contextual cues, visual cues (such as body language), temporal cues, and verbal cues. For many years, communication researchers have focused on how different technologies can affect human communication.

Face-to-Face vs. Computer Mediated Communication

Face-to-face communication.

Basic communication theories have tended to approach communication from the following different perspectives: (a) the communicator, (b) the message, (c) the conversation, (d) the relationships, (e) the group, (f) the group within the organization, (g) the media, (h) the communication medium, and (i) within culture and society (Littlejohn & Foss, 2005). For the purposes of this literature review the focus will be directed at the perspective of the "message", the "group" and later the "medium" used to convey the message. Obviously, the key to this review lies in what factors seem to improve or inhibit effective team communication.

Communication scholars have been less interested in the structure of language and mental linguistic rules and more interested in how people actually bring language and behavior together into discourse to accomplish goals (Littlejohn & Foss, 2005). An important aspect of this process is that we integrate verbal, or linguistics, and nonverbal elements. Communication scholars recognize that language and behavior more often than not work together; but, scholars disagree about what nonverbal communication is.

Nonverbal communication is often times referred to as nonverbal codes in communication research. Nonverbal codes are clusters of behaviors that are used to convey meaning. Therefore, nonverbal signals such as facial expressions and vocal intonation cannot be classified into discrete categories, but rather as gradations. The meaning attached to nonverbal forms of communication is context-bound, or determined in part by the situation in which they occur.

Another important form of communication includes paralanguage or paraverbal communication, which involves how something is said and not the actual meaning of the spoken words. Some examples of paralanguage are the cadence, tone, and number of pauses in a spoken message (Harper, Wiens, & Matarazzo, 1978). Much research has shown that even in face-to-face environments much confusion can exist as it relates to nonverbal and paralanguage communication.

Computer-mediated communication.

When considering computer mediated group decision-making settings, it is important to consider the relation to the much more extensively studied centralized face-to-face settings (Beroggi, 2003). A substantial body of research on computer-mediated communication has been conducted in the past several decades. Some studies indicated that team members working together using computer-mediated communication interactions were impaired as compared to face-to-face interactions (Driskell, Radtke, & Salas, 2003).

There are two major approaches to understanding the effects of different types of communications media. Theories of social presence (Short, Williams, & Christie, 1976) and media richness (Daft & Lengel, 1984) held that the capacity to transmit communicative information (visual, verbal, and contextual cues) is progressively restricted as one moves from face-to-face to video to audio only to text modes of communication.

The computer-mediated communication research indicates that computer communication technologies that limit or restrict contextual cues, visual cues, temporal cues and verbal cues are more likely to lead to miscommunication in group settings. Daft and Lengel (1984) proposed that communication media have varying capabilities for resolving ambiguity, negotiating varying interpretations, and facilitating understanding. They presented a media richness hierarchy, arranged from high to low degrees of richness, to illustrate the capacity of media types to process ambiguous communication in organizations. The four criteria are as follows: i) the ability for instant feedback; ii) the capacity of the medium to transmit multiple cues such as body language, voice tone, and inflection; iii) the use of natural language, and iv) the personal focus of the medium. Therefore, face-to-face communication is the "richest" communication medium possible.

A number of studies have found that computer-mediated groups exchange less information than face-to-face groups (Hollingshead, 2001). The information suppression effect of computer-mediated communication was also found by McLeod, Baron, Marti, and Kuh (1997). In some cases, this reduction can lead to poorer outcomes. Straus and McGrath (1994) examined the quality and quantity of group performance on three different tasks with and without computer-mediated communication. The three tasks were brainstorming, solving a problem with a correct answer, and making a decision that did not have a correct answer. In general, face-to-face groups were more productive than computer-mediated groups, that is, they generated more discussion and possible solutions on all three tasks.

Hollingshead (1996) also examined the impact of procedural factors on information sharing and group decision quality. Groups instructed to rank order the alternatives, compared with groups instructed to choose the best alternative, were more likely to fully consider all the alternatives, exchange information about unpopular alternatives, and make the best decision. However, these effects occurred only in face-to-face groups. In computer-mediated groups, there was general information suppression and no effect on group decision procedure. Groups expressed more difficulty communicating and reaching consensus in computer-mediated environments.

Hollingshead (2001) identified the following findings as particularly important and relevant to the study of groups in social and organizational settings: (a) nonverbal communication and paralanguage play an important role in the exchange of information, particularly for people who know each other well; (b) computer-mediated communication can lead to information suppression: a reduction in the amount of information that computer-supported groups discuss and use in their decisions relative to face-to-face groups; (c) status differences among members affect patterns of participation, influence, and group outcomes in similar ways in both face-to-face and computer-mediated groups; and (d) groups adapt to their communication medium quickly, so many of the observed effects in comparisons between face-to-face and computer-mediated groups may disappear over time.

Therefore, it is reasonable to assume that groups that are limited to communicating via computer-mediated or virtual environments that restrict necessary communication cues will have more difficulty integrating group member inputs and therefore will be less likely to achieve the assembly effect. This assumption is the premise for several of the hypotheses in this study.

Technology-Mediated Communication and Group Decision-Making

Several scholars have presented literature reviews that examined the impacts of technologies on groups (Gillam & Oppenheim, 2006; Hollingshead & McGrath, 1995; Martins, et al., 2004; McLeod, 1992, 1996; Powell, et al., 2004). Most of these reviews have compared the interaction processes and outcomes of computer-mediated groups to those of face-to-face groups. Reviews that are more recent have started to focus more on virtual team environments. Several of those reviews have reached the same conclusions about the state of knowledge in this area. Namely, much of the empirical research is unclear and fragmented (B. S. Bell & Kozlowski, 2002), and that more theory-guided and programmatic research is needed (Hertel, Geister, & Konradt, 2005; Hollingshead, 2001; Martins, et al., 2004).

A number of studies have found that computer-mediated groups exchange less information than face-to-face groups (Hollingshead, 1996; Straus, 1996). Straus and McGrath (1994) reported that computer-mediated team members had a harder time understanding one another than did face-to-face teams; and, Straus (1996) found that computer-mediated team members were less satisfied with the task process than face-to-face members.

Longitudinal research comparing the impact of computer-mediated and face-to-face communication over time has brought into question findings of previous studies that have found significant differences in performance between face-to-face and computer-mediated groups. That research has shown that computer-mediated communication hinders the interaction process and performance of groups initially; but, over time, groups can adjust successfully to that mode of communication (Alge, Wiethoff, & Klein, 2003; McGrath, Arrow, Gruenfeld, Hollingshead, & O'Connor, 1993).

In recent research, a number of simulations, called internet-mediated simulations, have been developed that utilize the Internet and Web-based communication components. An internet-mediated simulation can provide significant benefits. It can provide a dynamic environment that cannot be controlled by any one user. It can also provide a medium that can utilize the extensive communication capabilities of the Internet. Moreover, individuals or groups using this simulation do not have to be in the same location at the same time. This presents some interesting possibilities in research such as development of teams that span departments, organizations, countries, and continents (Dasgupta, 2003).

The theories of social presence and media richness support the idea that the best communication mediums allow for the most communicative cues. As stated previously, video communication environments are second only to face-to-face communication environments. Therefore, video environments should facilitate better communication and decisions than text environments. As Kezsbom (2000) stated, "Even in the best videoconferencing, facial expressions can be difficult to pick up if the transmission is poor, if someone is off camera, or if sound quality is poor. Unfortunately, the bulk of evidence on the value of adding video capabilities to computer-mediated systems is not supported (Driskell, et al., 2003). Warkentin, Sayeed, and Hightower (1997) found that teams using an Internet-based asynchronous computer conference system could not outperform traditional face-to-face settings. Additionally, Andres (2006) found that face-to-face teams had more effective group processes and were more productive than videoconferencing teams. These findings warrant further research focusing on the use of decision-making teams in internet-based video communication technology environments. This study incorporates a videoconferencing communication environment to validate the findings to date in this line of research.

Work Teams and Technology-Mediated Communication

In today's work environment, teams may operate either in face-to-face environments or in virtual environments that depend on computer-mediated communication technologies. Many advances in technology have also had a profound effect on the workplace and the use of teams. Today, and for the foreseeable future, work will continue to be done by people; and, those people will have to be able to collaborate and work together in groups as work continues to become more complex and knowledge-based (Beyerlein, et al., 2003). Additionally, many of these new complex jobs have resulted from a rapid infusion of technology and communication systems into virtually every organization and every function within the organization.

Advances in computer and communication technologies combined with the ever-decreasing cost of these technologies have allowed for a more geographically dispersed workforce that challenges the traditional notion of the workplace. Advances in communication and computer technology have changed the nature of work and how people work together. Many of these technologies have become necessities in today's technologically advanced workplace. Because individual team members can often be located in different buildings, different cities, different regions, and in different countries, computer-mediated technologies are often used to assist work groups in completing their tasks.

Pervan (1998) reviewed the extensive body of literature in Group Support Systems (GSS), and identified the need to conduct more conceptual work coupled with empirical studies to extend the current theories and previous research studies. Evidence supporting the notion that GSS led to more efficient and accurate decisions is somewhat belied by findings providing evidence for GSS not increasing group consensus and lowering decision quality (Hiltz, Dufner, & Poole, 1991). According to Dasgupta (2003), the fact that GSS does not increase group consensus or group decision quality is cause for concern because a large portion of decision making done in organizations today is done in dynamic and asynchronous environments using e-mail and other information technologies.

Most individuals in businesses today do not have the luxury of having access to GSS systems and will use common communication systems which are typically provided by most businesses (such as e-mail, instant messaging, texting and cell phones) to interact as a group and make decisions. Dasgupta (2003) proposed that Internet-mediated simulations can provide a dynamic process environment in which group decision-making can be studied, and recommended additional research in the area of asynchronous and synchronous decision-making in an uncontrolled and dynamic environment. Dasgupta (2003) also stated that managers will benefit from additional research in this area because most group decisions are made in dynamic uncontrolled environments similar to the environment created by Internet-mediated environments.

Virtual Team Research

Virtual teams are becoming a more common type of work unit and are expected to play an increasingly key role in organizations (Hertel, Konradt, & Orlikowski, 2004). Virtual teams are often defined as groups who use technology to work and interact with one another across multiple boundaries (geography, time, organizational) to accomplish common goals (B. S. Bell & Kozlowski, 2002). As stated earlier, virtual teams are becoming commonplace in today's larger business organizations (Kanawattanachai &

Yoo, 2002). It is this proliferation of virtual teams in our corporate environment which justifies a continued need to better understand the effectiveness of these teams through both experimental and field study research.

The literature on virtual teams falls into two main categories. First, the benefits and problems of virtual working as compared to working face-to-face, and secondly, the factors that impact on virtual team effectiveness (Lin, Standing, & Liu, 2008). Lin et al. also stated that performance and satisfaction represent the two major measures of effectiveness of virtual teams. A wide range of factors has been identified in the literature as affecting the effectiveness of virtual teams. Features of relationships including the diversity of the team, team cohesiveness, team status, and communication within the team are all seen as important. Other factors that affect team effectiveness include team member expertise, extraversion of team members and group interaction styles.

A number of theoretical perspectives have been employed to guide previous virtual team research. This theoretical pluralism is not surprising since no unifying theory of virtual teams currently exists (Powell, et al., 2004). Most of our current understanding of virtual teams has come from laboratory research comparing traditional (face-to-face) teams to teams that mainly communicate in technology-mediated environments (Baltes, et al., 2002).

Schmidt, Montoya-Weiss and Massey (2001) compared individuals, face-to-face teams and virtual teams on decision-making effectiveness. They concluded that teams make more effective decisions than individuals, and virtual teams made the most effective decisions. By contrast, Alge et al. (2003) found that temporary teams (extent to which they have a past or expect to have a future) affects face-to-face and virtual teams' ability to communicate effectively and make high-quality decisions. For teams lacking a history, results indicated that technology media exacerbated these differences.

The general consensus is that the nature of interaction in virtual teams may differ in a number of important ways from face-to-face team interaction (Driskell, et al., 2003). Branson, Moe and Sung (2005) found that virtual teams process less information than individuals and face-to-face teams. Brenson et al. also found that virtual teams spend more time managing the team processes and less time in processing information and decision making, even when the task is a decision-making task.

As with all teams, for virtual teams to achieve their objectives and successfully complete tasks, information must be effectively exchanged (Powell, et al., 2004). Limitations of media in a virtual environment may limit the quantity and quality of information. It would appear that the virtual team research is consistent with much of the computer-mediated research in that face-to-face teams tend to be more effective than virtual teams.

Computer Mediated and Virtual Team Research Summary

Past research focusing on teams in computer-mediated environments has produced inconsistent results. Despite the level of research interest in virtual teams, there is still uncertainty in relation to an integrated set of factors that contribute to virtual team effectiveness (Lin, et al., 2008). To address this issue, this research is necessary to further the understanding of Internet-mediated communication modes with differing levels of media richness impact on a team's ability to achieve the assembly effect.

Additionally, most group decisions in real life are still made in an uncontrolled, asynchronous or synchronous environment (Dasgupta, 2003). Moreover, recent advances in Internet technology and Internet-mediated communications in particular, provide unique opportunities for the study of uncontrolled process environments. To address this issue, this research used common low-cost Internet-mediated communication modes that are available to the vast majority of organizational work teams and are similar to the Internet communication tools used on a daily basis in today's work environment to make team decisions.

CHAPTER THREE – METHODS AND PROCEDURES

Introduction

The major issue addressed in this study was to establish what combination of factors either contributes to, or inhibits, the occurrence of the assembly effect in decision-making teams. The present study sought to build upon the systematic development of previous studies on group decision quality; therefore, it is reasonable for this study to utilize similar subjects, procedures, and measures as past research.

Research Design

This study utilized an experimental between-groups factorial design to answer the research questions. The independent variables in the study were team decision mode and team communication mode. The team decision mode independent variable consisted of two levels (consensus instructed and not-instructed). The team communication mode consisted of three levels (face-to-face, instant messaging, and videoconferencing). The dependent variables were several calculated measures including individual error score (IES), team error score (TES), utilization of average resources index (UARI), utilization of best-member resources index (UBRI), and the occurrence of the assembly effect.

Participants

The participants in the research study were students at a mid-sized Midwestern state university enrolled mainly in Introduction to Management, Introduction to Marketing and Workforce Education graduate courses during the Summer and Fall 2009 semesters and the Spring 2010 semester. Students were incentivized to participate in the study by the chance to earn a $10 gift card to a retail store. This student sample represented a convenience sample and is not representative of the entire university student population. However, students were randomly assigned to groups and their experimental condition. A total of 358 students completed the study, representing 105 groups composed of three-person or four-person teams. All teams whom successfully completed the experimental phase of the study were included in the statistical analysis.

Method of Team Formation and Assignment

The method used to form teams and the criterion used to determine team size and composition for later data analysis were mainly drawn from the established methodology used by Kandell (1992), Waugh (1996), Potter and Balthazard (2002) and Stapleton (2006). This study's methodology was different in two significant ways. First, studies such as this in the past usually had only one phase of data collection. The subjects completed the decision task both individually and with their group in the same session (Innami, 1994; Kandell, 1992; Waugh, 1996). In this study, the individuals completed the NASA decision task individually in phase one; then, several weeks later completed the task with their team again in phase two. Stapleton (2006) also used a two-phase data collection for his study using the Winter Survival task. Secondly, subjects completed the NASA decision task using an online questionnaire; whereas, in the previous studies, the decision tasks were completed by hand.

For phase one of the study, subjects were asked to visit a website to complete a short demographic survey and to complete the NASA "Lost on the Moon" decision task individually. For phase two of the study, students were randomly assigned to four-person teams using a computerized random subject generator combined with an online scheduling system that took into consideration subject availability for scheduled experiment times. When at least three members of a team showed at the team's scheduled session time for the study, the subjects were asked to complete the NASA "Lost on the Moon" decision task as a team. This resulted in 62 three-person and 43 four-person teams.

A stratified random sampling procedure was used to create as many teams as possible that included at least one member of each gender. Then each team was assigned either to the "instructed consensus" condition or the "not-instructed" condition using the random number generator with teams obtaining a "1" being assigned to the "instructed consensus" condition, and teams obtaining a "2" being assigned to the "not-instructed" condition. This resulted in 52 teams being assigned to the "instructed consensus" condition, and 53 teams being assigned to the "not-instructed" condition. Then, the teams from each consensus condition were randomly assigned to one of the three communication mode conditions using a computerized random number generator combined with the space availability needed to run the IM and video conditions. Teams assigned a "1" were in the "face-to-face" condition. Teams assigned a "2" were in the "instant messaging" condition. Teams assigned a "3" were in the "videoconferencing" communication mode condition. This resulted in 39 teams in the "face-to-face" communication mode condition, 36 teams in the "instant messaging" Internet communication mode condition, and 30 teams in the "videoconferencing" Internet communication mode condition.

Thus, the following six cells of groups were produced: (a) face-to-face/instructed (n = 19), (b) face-to-face/not-instructed (n = 20), (c) instant messaging/instructed (n = 18), (d) instant messaging/not-instructed (n = 18), (e) videoconferencing/instructed (n = 15), and (f) videoconferencing/not-instructed (n = 15).

Measures and Instruments

The NASA "Lost on the Moon" decision task. To assess decision-making performance, the NASA "Lost on the Moon" decision task (Hall & Watson, 1971) was used. The NASA decision task requires that each individual and/or group rank a list of 15 items in terms of their importance to survival from the salvaged wreckage of their spaceship that has crash-landed on the Moon.

There are several reasons to use the NASA decision task. First, this decision task has a history of being used in several previous studies that assessed the differences in the quality of both individual and group decision-making (Bottger & Yetton, 1988; Innami, 1994; Nemiroff & King, 1975; Potter & Balthazard, 2002; Waugh, 1996). Second, the NASA decision task offers a practical means of assessing quality of complex decision making because of the fact that there is only one objective correct answer. Quality of decision-making can be easily and objectively measured through deviations from the correct ordering of the task items. Third, the NASA decision task is novel to most college students and it is extremely unlikely that any group member would possess expertise in space survival. Finally, the NASA decision task represents a complex problem-based situation that is not unlike the situations that often occur in work groups found in organizations. The calculations used to assess both individual and team performance (decision quality) on the NASA "Lost on the Moon" decision task are discussed in the performance measures section below.

Performance Measures

The nature of the NASA task lends itself to multiple estimates of group performance. The four performance measures used in this study are exactly the same as those used by Nemiroff and King (1975), Waugh (1996) and Stapleton (2006). How each performance measure was obtained and its importance are described in detail in the following sections.

Individual Error Score (IES)

This score is a calculation of the individual's solution to the NASA decision task as compared to the objectively correct solution provided by NASA experts. The individual score is figured by subtracting the individual's ranking on the 15 items from NASA's solution key ranking and then summing the absolute deviations. For example, if a list of three items were ranked by the individual as 1, 2, 3, but the ranking should have been 3, 2, 1, the individual's score is calculated as such ((1-3) + (2-2) + (3-1)) = 4. Lower scores indicate higher agreement with the decision experts and thus a higher decision quality. Individual error scores on the NASA decision task can range from 0 to 120 points.

Team Error Score (TES)

This score is a calculation of the team's solution to the NASA decision task as compared to the objectively correct solution provided by NASA experts. The team score is figured by subtracting the team's ranking on the 15 items from NASA's solution key ranking and then summing the absolute deviations. For example, if a list of three items were ranked by the team as 1, 2, 3, but the ranking should have been 3, 2, 1, the group's score is calculated as such ((1-3) + (2-2) + (3-1)) = 4. Lower scores indicate higher agreement with the decision experts and thus a higher decision quality. Team error scores on the NASA decision task can range from 0 to 120 points.

Utilization of Average Resources Index (UARI)

This measure represents a pooled or averaged individual error score which gives a baseline to assess the difference of the group's decision quality index as compared to its individual member's decision quality (Hall & Williams, 1966). This was used to determine the effectiveness of the group to utilize their members' resources to reach a group solution. This is a measure of procedural effectiveness that indicates either a process gain or process loss in decision quality based on the team's score (Team Error Score) as compared to the mean performance of its member's scores (Individual Error Score) on the decision task. The UARI was calculated by subtracting the team's error score from the mean individual error score (TES – AvgIES), which is calculated by subtracting each individual team member's rankings from the objective NASA rankings, then averaging the individual error scores. Therefore, a positive score represents an effective utilization of group member's average resources (process gain), while a negative score represents an ineffective use of team member's average resources (process loss) (Steiner, 1972).

Utilization of Best-Member Resources Index (UBRI)

This measure is similar to the UARI, except that it allows an evaluation of the group's effectiveness by utilizing the resources of their best member to reach the group's solution (Hall & Williams, 1970). In essence, did the group perform better on the decision task than its best member did individually on the decision task? The UBRI was calculated by subtracting the team error score (TES) from the score of the lowest individual error score (best-member's score). Like the UARI, for the UBRI, a positive score represents an effective utilization by the group of the resources of its best member (process gain). While a negative score represents an ineffective utilization of the best member's resources (process loss) to produce the group's solution to the decision task.

Assembly Effect (AE)

This measure is used to assess group performance that exceeds the performance of any member working alone or a summative combination of individual efforts which is known as the "assembly effect" (Collins & Guetzkow, 1964). Groups whose performance on the NASA decision task achieved the assembly effect (positive UBRI score) were assigned a value of 1, while those groups that did not achieve the assembly effect (negative UBRI score) received an assigned value of 0. The frequency of assembly effect achieved was then compared to the frequency of the assembly effect not achieved.

Decision-Style Questionnaire

A decision-style questionnaire adapted from both Nemiroff and King (1975) and Waugh (1996), and previously used by Stapleton (2006), was given to each team member at the completion of the team decision task. The purpose of the decision style questionnaire is to measure the frequency in which teams used nonconsensual decision techniques as opposed to consensual decision techniques during the team decision task process. Possible other non-consensus decision techniques used include majority rules voting, averaging, and trading. The decision-style questionnaire was used to verify that the teams who received consensus instruction did indeed use the nonconsensual decision techniques less often than not-instructed teams. This was measured by each participant answering three questions at the completion of the decision task that asked them to write down the frequency (number) of times the team used each one of the non-consensus decision techniques listed on the questionnaire (Appendix F).

Procedures

The procedures in the experimental study were adapted from Stapleton (2006), Potter and Balthazard (2002), Waugh (1996) and Kandell (1992) in an attempt to validate and compare their previous results to the results of this study. As mentioned previously, this study attempted to support past research findings that have found that consensus training is effective in facilitating team communication processes that lead to the assembly effect. Uniquely, this study also determined if differing Internet-mediated communication environments interact with consensus instruction to affect a team's ability to obtain the assembly effect.

Initial Data Collection

In phase one of the study, during the first couple of weeks of the Summer and Fall 2009 semesters, and the Spring 2010 semester, students from the Introduction to Management and Introduction to Marketing courses were instructed to visit a website and complete a demographic questionnaire and the NASA "Lost on the Moon" decision task individually. Students were also asked to provide scheduling preferences for predetermined study participation time slots. The study subjects were stratified by gender and randomly assigned to teams and the experimental conditions taking into consideration subject scheduling preferences.

Laboratory and Technology Preparation

During the Summer and Fall semesters of 2008, a pilot study was conducted to test the reliability of the internet-mediated technology applications, assess student abilities to use these applications, and determine appropriate methodological procedures for the future dissertation study. Approximately four teams completed each of the

Internet-mediated conditions for a total of 16 teams. The data from the pilot study was not analyzed statistically.

The experimental phase of the study was conducted during the Summer and Fall semesters of 2009 and the Spring semester of 2010. For subjects in the face-to-face condition, the teams were separated into separate rooms so two teams would be able to participate in the study concurrently. A packet was placed on each chair, which denoted the group number of the team and the team's respective experimental condition. Each packet contained the following: (a) a copy of the original informed consent form which was initially completed online in phase one; (b) phase two, group phase instructions specific to the experimental condition the group was assigned to; (c) the NASA "Lost on the Moon" decision exercise and instructions; (d) the decision-style questionnaire to be completed by each individual team member immediately following the completion of the NASA decision task; and (e) for teams in the consensus instruction condition, the instructions for reaching consensus document.

For subjects in the Internet-mediated communication mode (Instant Messaging and Videoconferencing) condition, subjects were placed into separate rooms at a computer station so subjects could only interact (communicate) with their other team members via the internet-mediated software program provided. Similar to the face-to-face condition, a packet was placed at each computer station denoting the group number and the team's experimental condition. Each packet contained the same documentation listed above in the face-to-face condition.

Team Decision Task Exercise

Team members were instructed by the researcher to open their respective packet and review the original informed consent form and reminded that it was voluntary to participate in the study. Subjects were instructed to read the Group Phase instructions and informed by the researcher that the team would work together to create a team ranking for the NASA "Lost on the Moon" decision task. At this point, subjects were given the opportunity to ask questions if they did not understand the nature of the study and/or their role in the study.

For the teams that were randomly assigned to the "consensus instructed" condition, the subjects were then given time to read the Instruction for Reaching Consensus document and instructed briefly on the information provided in the document. Again, subjects were given an opportunity to ask questions if they needed further clarification on consensus building in teams. Then, the team members were asked to review the Decision-Style Questionnaire and instructed to complete the Decision-Style Questionnaire individually (without the assistance of the other team members), immediately following the team's completion of the NASA decision task. The teams were instructed to pick one member of the team to record the "official" team's rankings for the NASA decision task before starting to work together as a team on the NASA decision task. No formal leader was assigned in the team.

For the teams that were randomly assigned to the "not-instructed condition", the team members were then asked to review the Decision-Style Questionnaire, and instructed to complete the Decision-Style Questionnaire individually (without the assistance of the other team members) immediately following the team's completion of the NASA decision task. These teams did not have the consensus training materials in their packet; therefore, these teams used whatever decision techniques their team deemed appropriate to complete the NASA decision task.

After all other instructions were given, in the Internet-mediated communication mode conditions, the team members were instructed to complete the NASA decision task as a group using only the Internet communication software provided. Teams that were randomly assigned to the “Instant Messaging” condition were briefly instructed to use the open Windows Live Messenger™ window to complete the NASA decision task. Team members worked together on the NASA decision task by simply typing their contributions to the team task into the Live Messenger text box and followed the group’s discussion thread for the team task via the Live Messenger discussion box. A screen capture of the Windows Live Messenger™ Application is provided in Appendix H.

For subjects in the “Videoconferencing” condition, the procedures for the study were exactly the same as the “Face-to-Face” and “Instant Messaging” conditions. Except in this condition, the subjects were instructed to use the ooVoo™ videoconferencing “net meeting” software application that allowed the team members to both see and hear the other team members via digital videoconferencing to complete the NASA decision task. A screen capture of the ooVoo™ videoconferencing application is shown in Appendix I. As with the other conditions, one team member recorded the team’s rankings for the NASA decision task on the provided form and submitted this form to the researcher at the completion of the experimental session. All teams were given up to one hour to complete the team NASA decision task. Most teams were able to complete the NASA decision task in 30 minutes or less.

Decision-Style Questionnaire

Immediately following the completion of the team task, each team member completed the three question Decision-Style Questionnaire. At the completion of the experimental session, the recorder for each team returned the NASA decision task form back to the researcher and each team member returned his or her completed Decision-Style Questionnaire to the researcher. The subjects were then informed that the study was complete and they were free to leave.

Treatment of Data

Initial data from the demographic survey and the individual rankings of the NASA decision task were collected online and recorded electronically. This data were exported into Excel for organization and computation purposes. The team rankings of the NASA decision task and the Decision-Style Questionnaire were collected manually and were manually input into Excel. After the data were cleaned, organized and the Index scores were computed in Excel, the data were imported into SPSS version 16 for analysis. Several steps were taken to insure the integrity of the data and the integrity of the data analysis. An overview of the steps taken are mentioned below:

1. All instruments utilized in each phase of the study were identified with unique reference numbers that included participant's names, team numbers, and experimental conditions. This information was recorded in a master electronic file and cross-referenced with the original electronic and hard copy data.
2. Immediately after each phase of data collection, exploratory analysis was performed to ensure that the data were recorded properly

3. A random sampling of records in the master data file were compared with the original data instrument, rescored, and verified that the data was accurate.
4. Coding of variables for statistical analysis was verified against the master data file and the data source file in SPSS. Finally, all SPSS analyses were run more than once and directionality of variables were verified against the master data file.

Based on the procedures above, all of the records that were used in the SPSS dataset for analysis were verified as accurate.

Data Analysis

Demographics

Prior to the research experiment, demographic information was collected on the subjects via an online questionnaire designed in Qaultrics™. The purpose of the demographic questionnaire was to define the population of this research study. Information collected included age, gender, ethnicity, academic major, and academic classification.

Effectiveness of Treatment

Hall (1971) found that simply providing subjects with a list of guidelines on building consensus in a team was sufficient to facilitate consensus behavior among members of a team during the NASA "Lost on the Moon" decision task. Even though consensus-seeking instruction has been quite successful in increasing decision quality of groups in past group decision task research (Hall, 1971; Nemiroff & King, 1975; Waugh, 1996), it is still important to determine whether the group consensus instruction in this study is effective in increasing the use of consensus decision techniques in the "instructed consensus" groups. The decision style questionnaire used three questions that are continuous measures; therefore, an independent sample *t*-test was used to compare the mean frequencies of alternative decision approaches among the teams who received the consensus instruction and the teams who did not receive consensus instruction.

Interrater Agreement

Nemiroff and King (1975) showed in their previous research that group members were able to assess the decision techniques used during the team decision task and that group members generally agreed on the frequency of alternative decision techniques used by the team. An analysis on the percentage of team members who agreed on the frequencies of times their team used alternative decision techniques (majority voting, averaging, and trading) were calculated for this study to insure that the teams could accurately assess the decision techniques utilized and to validate the frequencies used to assess the effectiveness of treatment.

Univariate Analysis

Several measures of group performance on the NASA decision task were computed. Therefore, several statistical analyses were required to test the hypotheses seen in Table 1. Each specific analysis is described for each measure of group performance and its related hypotheses below.

Comparison of team scores.

To identify significant group score main and interaction effects, a 2 X 3 Between Subjects Factorial Analysis of Covariance (ANCOVA) using the team error scores (TES) as the dependent variable was conducted. The two factors represented in the ANCOVA were mode of instruction (instructed vs. not-instructed) and mode of communication (face-to-face vs. instant messaging vs. videoconferencing). To control for possible extraneous factors (confounding effects) between groups due to inequality of available member resources, the mean individual error scores (IES) and best member's error scores served as covariates. Planned contrasts were also conducted for the appropriate hypotheses.

Utilization of average resources.

A 2 X 3 Between Subjects Factorial Analysis of Variance (ANOVA) was conducted to identify significant utilization of average resource index (UARI) main and interaction effects. The UARI served as the dependent variable. Again, the two factors represented in the ANOVA were mode of instruction (instructed vs. not-instructed) and mode of communication (face-to-face vs. instant messaging vs. videoconferencing). Planned contrasts were also conducted for the appropriate hypotheses.

Utilization of best-member resources.

The statistical analysis used to indentify significant main and interaction effects in the utilization of the best member's resources was a 2 X 3 Between Subjects Factorial Analysis of Variance (ANOVA) with the (UBRI) serving as the dependent variable. Like the two previous analyses, the two factors represented in the ANOVA were mode of instruction (instructed vs. not-instructed) and mode of communication (face-to-face vs. instant messaging vs. videoconferencing). Again, planned contrasts were also conducted for the appropriate hypotheses.

Assembly effect.

A Chi Square test of Independence was conducted to identify significant main and interaction effects in the frequencies of teams that achieved the assembly effect (AE). The occurrence or lack of the occurrence of the assembly effect served as the dependent variable. Again, the two independent variables represented in the Chi Square test for Independence were mode of instruction (instructed vs. not-instructed) and mode of communication (face-to-face vs. instant messaging vs. videoconferencing). Planned contrasts were performed for the appropriate hypotheses.

Multivariate Analysis

This study is adding a unique contribution to this research area by using an additional statistical technique that has traditionally not been used in similar past research. Past research has typically used Univariate analysis only; but, this study went one-step further and also used a Multivariate MANOVA analysis. According to Bray and Maxwell (1985), the MANOVA analysis is appropriate when the researcher wants to control for experiment wide error rate, gain a better understanding of how the variables are intercorrelated and possibly increase statistical power if there are less than five dependent variables and the variables are moderately correlated.

A 2 X 3 Between Subjects Two Factor Multivariate Analysis of Variance (MANOVA) was conducted to determine significant main and interaction effects for the utilization of average resources index (UARI) and the utilization of best member's resources (UBRI). The dependent variables for the MANOVA analysis were the utilization of average resources index (UARI) and the utilization of best-member's resources index (UBRI). The two nominal factors were decision mode (instructed vs. not-instructed) and communication mode (face-to-face vs. instant messaging vs. videoconferencing). Again, planned contrasts were conducted for the appropriate hypotheses. The experimental hypotheses, dependent variables and the statistical analysis conducted for the hypotheses are shown in Table 1.

Table 1

Statistical Analysis of Performance Measures by Hypothesis

Hypothesis	Variables	Statistical Analysis
H_1: Controlling for differences in individual ability, the team scores of face-to-face teams are significantly lower (better) than the team scores of instant messaging teams and video conferencing teams.	COV: Individual Scores on NASA Survival Exercise DV: Team Scores on NASA Survival Exercise	2 X 3 Analysis of Covariance Planned Contrasts
H_2: Controlling for differences in individual ability, the team scores of consensus instructed teams are significantly lower (better) than the team scores of not-instructed teams.	COV: Individual Scores on NASA Survival Exercise DV: Team Scores on NASA Survival Exercise	2 X 3 Analysis of Covariance
H_3: An interaction effect is evident in that, controlling for individual differences in ability, the team scores of face-to-face/consensus instructed teams are significantly lower (better) than the team scores in all other conditions.	COV: Individual Scores on NASA Survival Exercise DV: Team Scores on NASA Survival Exercise	2 X 3 Analysis of Covariance Planned Contrasts
H_4: The decision quality improvement of team performance over the average performance of the team's members is significantly greater in face-to-face teams than the instant messaging teams and video conferencing teams.	DV: Utilization of Average Resource Index	2 X 3 Analysis of Variance Planned Contrasts
H_5: The decision quality improvement of team performance over the average performance of the team's members is significantly greater in consensus instructed teams than the not instructed teams.	DV: Utilization of Average Resource Index	2 X 3 Analysis of Variance

table continues

Hypothesis	Variables	Statistical Analysis
H_6: An interaction effect is evident in that the decision quality improvement of team performance over the average performance of the team's members is significantly greater in the face-to-face/consensus instructed teams than in all other conditions.	DV: Utilization of Average Resource Index	2 X 3 Analysis of Variance Planned Contrasts
H_7: The decision quality improvement of team performance over the team's best member is significantly greater in face-to-face teams than the instant messaging teams and video conferencing teams.	DV: Utilization of Best Member Resource Index	2 X 3 Analysis of Variance Planned Contrasts
H_8: The decision quality improvement of team performance over the team's best member is significantly greater in consensus instructed teams than the not instructed teams.	DV: Utilization of Best Member Resource Index	2 X 3 Analysis of Variance
H_9: An interaction effect is evident in that the decision quality improvement of team performance over the team's best member is significantly greater in the face-to-face/consensus instructed teams than in all other conditions.	DV: Utilization of Best Member Resource Index	2 X 3 Analysis of Variance Planned Contrasts
H_{10}: The proportion of face-to-face teams achieving the assembly effect is significantly greater than that of the instant messaging teams and that of the video conferencing teams.	DV: Frequency of teams achieving assembly effect	Chi Square Test of Independence
H_{11}: The proportion of consensus instructed teams achieving the assembly effect is significantly greater than that of the not-instructed teams.	DV: Frequency of teams achieving assembly effect	Chi Square Test of Independence

Hypothesis	Variables	Statistical Analysis
H_{12}: An interaction effect is evident in that the proportion of face-to-face/consensus instructed teams achieving the assembly effect are significantly greater than in all other conditions.	DV: Frequency of teams achieving assembly effect	Chi Square Test of Independence
H_{13}: The decision quality improvement of team performance over the average performance of the team's members and the team's best member are significantly greater in face-to-face teams than the instant messaging teams and video conferencing teams.	DVs: Utilization of Average Resource Index, Utilization of Best Member Resource Index	2 X 3 Multivariate Analysis of Variance Planned Contrasts
H_{14}: The decision quality improvement of team performance over the average performance of the team's members and the team's best member are significantly greater in consensus instructed teams than the not-instructed teams.	DVs: Utilization of Average Resource Index, Utilization of Best Member Resource Index	2 X 3 Multivariate Analysis of Variance
H15: An interaction effect is evident in that the decision quality improvement of team performance over the average performance of the team's members and the team's best member is significantly greater in the face-to-face/consensus instructed teams than in all other conditions.	DVs: Utilization of Average Resource Index, Utilization of Best Member Resource Index	2 X 3 Multivariate Analysis of Variance Planned Contrasts

CHAPTER FOUR – RESULTS AND ANALYSIS

Introduction

The major topic addressed in this study is to establish what combination of factors either contribute to, or inhibit, the occurrence of the assembly effect in decision-making teams. The results of this study are presented by first analyzing the participants, then the teams, then performance measures, then effectiveness of treatment, and finally by the research hypotheses. This chapter presents the results of this research study.

Demographic Results

Three hundred and fifty-eight (358) students successfully participated in Phase 1 and Phase 2 of the present study. Two hundred and one (201) of the participants were male (56.1%) and 157 were female (43.9%). The ages of the subjects ranged from 18 to 58, with a mean age of 23.34 years and a standard deviation of 4.66 years. The subjects were diverse with subject ethnicity consisting of 217 Caucasian/White (60.6%), 87 African/Black (24.3%), 19 Asian (5.3%), 19 Hispanic (5.3%), one Native American (.3%), and 15 other (4.2%).

Academic majors of the subjects were also diverse with 18 majors reported. Only one subject (.3%) did not report their major. The major with the most participants was Business, with 239 (66.9%) of the total 357 subjects who reported their major. The major, the number of subjects in each major, and the percentage in each major are shown in Table 2.

Table 2

Number and Percentage of Subjects by Academic Major

Major	Number of Subjects	Percentage
Business	239	66.8%
Liberal Arts	34	9.5%
Sciences	17	4.7%
Education	16	4.5%
Engineering	11	3.1%
Hospitality/Tourism	10	2.9%
Automotive Technology	6	1.8%
Architecture	4	1.2%
Human Nutrition	4	1.2%
Fashion Merchandising	3	.9%
Journalism	3	.9%
Other (Exercise Science, Agriculture, Information Systems, Healthcare Mgmt, Political Science, Forestry, Photography)	10	2.9%
No Response	1	.3%
Total	358	

Note: Percentages are based on 358 subjects.

Percentages do not add up to 100% due to rounding

The academic class standing of the subjects was primarily juniors. Specifically, the subjects included five freshmen (1.4%), nine sophomores (2.5%), 221 juniors (61.7%), 96 seniors (26.8%), and 23 graduate student subjects (6.4%). Four subjects (1.1%) did not include their academic class standing.

The highest degree attainment level for the subjects was largely high school graduate/some college. Specifically, 221 had completed high school with some college (61.7%), 85 had completed an associate's degree (23.7%), 45 had completed a bachelor's degree (12.6%), and four had completed a master's degree (1.1%). Three subjects (.8%) failed to report their highest degree attainment.

Team Formation

Each participant was randomly assigned to a four-person team for a total of N = 105 teams. A stratified random sampling procedure was used to create as many teams as possible that included at least one member of each gender. This resulted in 96 teams (91.4%) with both male and female participants, and nine teams (8.6%) made up of just one gender. Of the nine teams that consisted of only one gender, eight of the teams were all male and one team was all female.

Two between subjects factors were used to randomly assign participants to their respective teams. The first factor, decision mode, consists of two levels, the first being the "instructed consensus" condition and the second being the "not-instructed" condition. Each team was randomly assigned to either the "instructed consensus" condition or the "not-instructed" condition. This resulted in 52 (49.5%) teams being assigned to the "instructed consensus" condition and 53 (50.5%) teams being assigned to the "not-instructed" condition.

The second factor used to assign teams was communication mode. Communication mode consists of three levels; face-to-face, instant messaging and videoconferencing. This resulted in 39 teams (37.1%) in the "face-to-face" condition, 36 teams (34.3%) in the "Instant Messaging" condition, and 30 teams (28.6%) in the "Videoconferencing" condition. Thus, the following six cells of groups were produced from the two between subjects factors: a) face-to-face/instructed (n = 19) 18.1%, b) face-to-face/not-instructed (n = 20) 19%, c) instant messaging/instructed (n = 18) 17.1%, d) instant messaging/not-instructed (n = 18) 17.1%, e) videoconferencing/instructed (n = 15) 14.3%, and f) videoconferencing/not-instructed (n = 15) 14.3%.

Due to persistent scheduling issues of subjects, if at least three members of a team showed-up at the team's scheduled session time for the study, the subjects were asked to complete the NASA decision task with the team members present. This resulted in 62 three-person teams (59%) and 43 four-person teams (41%). The complete breakdown of the composition of teams is shown in Appendix J.

Performance Measures

The primary concern of this study was performance on a complex decision task of teams differing in decision mode and communication mode. To be consistent with past research, several performance measures were computed and analyzed. The performance measures included individual error scores (IES) and team error scores (TES) on the NASA decision task, the utilization of average resources index (UARI), the utilization of best-member's resources index (UBRI), and the occurrence/non-occurrence of the assembly effect (AE). The performance measures for each individual/team can be found in Appendix J.

The performance of the individual subjects as measured by the individual error scores (IES) on the NASA "Lost on the Moon" decision task ranged from 8 to 88, with lower scores indicating better performance. The mean task score for individuals was 52 with a standard deviation of 12. The performance of the teams as measured by the team error scores (TES) on the NASA "Lost on the Moon" decision task ranged from 20 to 60 (M = 38, SD = 9.46). Again, lower scores indicate superior performance.

The utilization of average resources index (UARI) is a measure of the team's ability to utilize its members' resources to reach a team solution to the decision task. Negative UARI scores indicate an inability of the team to utilize member's resources, while positive scores indicate an effective utilization of member's resources. The UARI scores ranged from -7.33 to 35.5 (M = 14.37, SD = 8.99).

The utilization of best-member's resources index (UBRI) is a measure of the team's ability to utilize its best-member's resources to reach a team solution to the decision task. Negative UBRI scores indicate an inability of the team to utilize the best member's resource while positive scores indicate an effective utilization of the best-member's resource. The UBRI scores ranged from -32 to 32 (M = 2.9, SD = 10.47).

As mentioned previously, the assembly effect is a measure used to assess team performance that exceeds the performance of any member working alone. The assembly effect occurs when a team achieves a positive UBRI score on the NASA decision task; 58 teams (55.2%) achieved the assembly effect while 47 teams (44.8%) failed to achieve the assembly effect.

Preliminary Analysis

Effectiveness of Treatment (Consensus Instructions)

An Independent Sample T-test was conducted to determine if the teams that received instruction in the consensus decision mode, before being asked to work together on the decision task, used nonconsensus techniques such as voting, averaging, and trading to obtain a team solution statistically less often than the teams that did not receive instructions.

As shown in Table 3, the teams that did not receive consensus instructions used voting, averaging and trading more frequently than the instructed consensus teams. The most frequently used nonconsensus technique for the teams who did not receive instruction was voting (M = 6.92), then trading (M = 2.58), and followed by averaging (M = 2.26). The mean difference for the instructed and not-instructed teams for all alternative decision methodologies (voting, averaging, and trading) was statistically significant. The mean difference for the instructed and not-instructed teams for voting was statistically significant at t (355) = 2.59, p = .01. The difference between the mean of the instructed and not-instructed teams for trading was statistically significant at t (356) = 2.62, p = .009. The difference between the mean of the instructed and not-instructed teams for averaging was statistically significant at t (356) = 3.28, p = .001. From the above data, it appears that the consensus instruction was effective in promoting consensus-seeking behaviors more often in the instructed teams. Table 3 shows the means, standard deviations, t-tests, degrees of freedom, and significance of the results of the Independent Sample T-test.

Table 3

Independent Sample T-test Mean Frequency of Nonconsensus Techniques Between Instructed and Not-instructed Teams

Comparison	Voting	Averaging	Trading
Instructed Consensus Teams			
Mean	5.27	1.23	1.82
Standard Deviation	5.99	2.37	1.99
Not-instructed Teams			
Mean	6.92	2.26	2.58
Standard Deviation	5.96	3.44	3.29
t score	2.59*	3.28**	2.62†
df	355	356	356

*p = .01, **p = .001, †p = .009

Interrater Agreement

To ascertain the agreement within the teams on the frequency the team used the non-consensus decision modes on the team decision task was calculated. The results of the analysis found that 56.7% of the team members agreed on the frequency of majority voting, 74.6% of the team members agreed on the frequency of averaging, and 72.1% of the team members agreed on the frequency of trading. The analysis did find a high degree of interrater agreement for averaging and trading among the teams, but there was a relatively low degree of interrater agreement for majority voting among the teams as compared to averaging and trading.

Primary Analysis

The hypotheses tested in this study compared several decision task performance measures among teams differing in the decision mode experimental condition (consensus instructed vs. not-instructed) and the communication mode condition (face-to-face, instant messaging, and videoconferencing). The number of teams in each condition, and the means and standard deviations for the different performance measures are summarized in Table 4.

Table 4

Summary of Condition/Cell Sizes, Means and Standard Deviations for Team Performance Measures

		Team Error Score		UARI		UBRI	
Team Condition	n	*M*	*SD*	*M*	*SD*	*M*	*SD*
Face-to-Face	39	36.87	9.33	16.36	8.31	4.21	8.12
Instant Messaging	36	38.44	9.81	12.71	8.84	2.89	10.56
Videoconferencing	30	38.93	9.37	13.78	9.81	1.2	12.915
Instructed Consensus	52	38.37	10.02	14.68	9.90	3.77	11.23
Not-instructed	53	37.74	8.97	14.06	8.09	2.04	9.69
Face-to-Face/Instructed	19	35.89	9.25	17.14	8.84	6.11	8.12
Face-to-Face/Not-instructed	20	37.80	9.55	15.62	7.92	2.40	7.91
Instant Messaging/Instructed	18	40.33	10.63	12.47	10.11	2.67	12.77
Instant Messaging/Not-instructed	18	36.56	8.80	12.94	7.64	3.11	8.15
Videoconferencing/Instructed	15	38.80	10.24	14.22	10.84	2.13	12.89
Videoconferencing/Not-instructed	15	39.07	8.77	13.34	9.02	.27	13.37

Comparison of Team Scores

A 2 X 3 between subjects factorial analysis of covariance (ANCOVA) was conducted to establish if team performance as measured by the team error scores on the NASA decision task were statistically significantly different between communication mode (face-to-face, instant messaging, and videoconferencing), decision mode (consensus instructed, not-instructed) and the experimental cells after controlling for possible inter-team differences due to each team members' individual error scores. In the ANCOVA analysis, the average individual error scores and the best-member's error scores obtained during the Phase 1 individual decision task exercise served as the covariates to control for any possible inter-team inequalities while the team's error scores obtained in the Phase 2 team decision task exercise served as the dependent variable.

The specific directional hypotheses tested by the ANCOVA analysis were:

H_1: Controlling for differences in individual ability, the team scores of face-to-face teams are significantly lower (better) than the team scores of instant messaging teams and video conferencing teams.

H_2: Controlling for differences in individual ability, the team scores of consensus-instructed teams are significantly lower (better) than the team scores of not-instructed teams.

H_3: An interaction effect is evident in that, controlling for individual differences in ability, the team scores of face-to-face/consensus instructed teams are significantly lower (better) than the team scores in all other conditions.

The initial results of the 2 X 3 ANCOVA showed that the best-member's scores ($F_{1, 97} = .74$, $p = .39$ at $\alpha = .05$) on the NASA decision task did not significantly influence the team's results on the NASA decision task. However, the analysis did find that the average individual error scores were a significant covariate ($F_{1, 97} = 6.67$, $p = .01$ at $\alpha = .05$).

Neither main effect nor the interaction effect approached statistical significance. Specifically, the mean team performance scores were in the predicted direction. The main effect for communication mode of the adjusted mean team performance scores of the teams in the face-to-face ($M = 36.87$), instant messaging ($M = 38.44$), and videoconferencing ($M = 38.93$) conditions were not statistically significant ($F_{2,97} = 1.01$, $p = .36$), $\eta = .02$ with power = .22.

To further test $H_{1,}$ a Helmert planned contrast analysis comparing face-to-face teams to all other communication mode conditions for mean team performance scores was conducted. The three conditions were divided into two groupings. Cell one (face-to-face) was one grouping and cells 2 and 3 (instant messaging and videoconferencing) were the second grouping. The contrast difference between was -2.51 ($SE = 1.77$). Compared to the null hypothesis that the difference between the groupings would equal zero, the contrast was not significant ($p = .16$).

The main effect for decision mode of the adjusted mean team performance scores of the teams in the consensus instructed condition ($M = 38.37$) versus the not-instructed condition ($M = 37.74$) was not significant ($F_{1,97} = .03$, $p = .86$), $\eta = .00$ with power = .05. The corresponding results of the ANCOVA analysis used to test H_1, H_2, and H_3 are shown in Table 5.

Table 5

Analysis of Covariance (ANCOVA) for the Team Score NASA Decision Task Performance Measure Controlling for Average Individual Error Score and Best-member Score

	df	F	P value	η	Power
Average Individual Error Score	1	6.67	.01	.06	.73
Best-member score	1	.74	.39	.01	.14
Communication Mode	2	1.01	.36	.02	.22
Decision Mode	1	.03	.86	.00	.05
Comm. Mode X Dec. Mode	2	.43	.64	.01	.12
Within	98				
Total	104				

Note. Communication mode refers to face-to-face, instant messaging and videoconferencing teams. Decision mode refers to consensus instructed versus not-instructed teams.

The mean team performance scores for the experimental cells were in the predicted direction. However, the interaction effect comparing the adjusted mean team performance scores in the face-to-face/instructed condition (M = 35.89), face-to-face/not-instructed condition (M = 37.80), instant messaging/instructed condition (M = 40.33), instant messaging/not-instructed condition (M = 36.56), videoconferencing/instructed condition (M = 38.80), and videoconferencing/not-instructed condition (M = 39.07) were not statistically significant ($F_{2,97}$ = .43, p = .64), η = .01 with power = .12.

To further test H_3, a Helmert planned contrast analysis comparing face-to-face/instructed teams to all other conditions was conducted. The six conditions were divided into two groupings. Cell one (face-to-face/instructed) was one grouping and cells 2, 3, 4, 5, and 6 were the second grouping. The contrast difference between was -.85 (*SE* = 2.18). Compared to the null hypothesis that the difference between the groupings would equal zero, the contrast was not statistically significant (p = .69). Therefore, neither H_1, H_2, nor H_3 for team error score were supported by the statistical analysis.

Utilization of Average Resources

The utilization of average resources index (UARI) measures a team's ability to utilize the resources of its members. The UARI is a degree of improvement or loss in team decision performance as compared to the average performance of the team's members. The UARI was calculated by subtracting the team's score from the average individual error scores obtained in phase 1. A between subjects 2 X 3 factorial analysis of variance (ANOVA) was conducted to establish if team performance as measured by the utilization of average resources index on the NASA decision task were statistically significantly different between communication mode (face-to-face, instant messaging, and videoconferencing), decision mode (consensus instructed, not-instructed) and the experimental cells. In this ANOVA analysis, the UARI team scores served as the dependent variable.

The specific directional hypotheses tested by this 2 X 3 ANOVA analysis were:

H_4: The decision quality improvement of team performance over the average performance of the team's members is significantly greater in face-to-face teams than the instant messaging teams and video conferencing teams.

H_5: The decision quality improvement of team performance over the average performance of the team's members is significantly greater in consensus instructed teams than the not-instructed teams.

H_6: An interaction effect is evident in that the decision quality improvement of team performance over the average performance of the team's members is significantly greater in the face-to-face/consensus instructed teams than in all other conditions.

For the analysis of variance for utilization of average resources index, neither main effect nor the interaction approached statistical significance. Specifically, the UARI mean scores were in the predicted direction for communication mode, but the main effect for communication mode of the teams in the face-to-face (M = 16.36), instant messaging (M = 12.71), and videoconferencing (M = 13.78) conditions were not statistically significant ($F_{2,99}$ = 1.63, p = .20), η = .03 with power = .34.

To further test $H_{4,}$ a Helmert planned contrast analysis comparing face-to-face teams to all other communication mode conditions on the UARI performance measure was conducted. The three conditions were divided into two groupings. Cell one (face-to-face) was one grouping and cells 2 and 3 (instant messaging and videoconferencing) were the second grouping. The contrast difference between was 3.13 (SE = 1.83). Compared to the null hypothesis that the difference between the groupings would equal zero, the contrast was not significant at (p = .09).

Again, the main effect for the UARI decision mode means were in the predicted direction, but the mean UARI performance scores of the teams in the consensus instructed condition (M = 14.68) versus the not-instructed condition (M = 14.06) were not statistically significant ($F_{1,99}$ = .13, p = .72), η = .00 with power = .06.

The mean UARI scores for the experimental cells were also in the predicted direction. However, the interaction effect comparing the UARI scores in the face-to-face/instructed condition (M = 17.14), face-to-face/not-instructed condition (M = 15.62), instant messaging/instructed condition (M = 12.94), instant messaging/not-instructed condition (M = 12.47), videoconferencing/instructed condition (M = 13.34), and videoconferencing/not-instructed condition (M = 14.22) were not statistically significant ($F_{2,99}$ = .12, p = .89), η = .00 with power = .06.

To further test $H_{6,}$ a Helmert planned contrast analysis comparing face-to-face/instructed teams to all other conditions for the UARI performance measure was conducted. The six conditions were divided into two groupings. Cell one (face-to-face/instructed) was one grouping and cells 2, 3, 4, 5, and 6 were the second grouping. The contrast difference between was 3.41 (SE = 2.29). Compared to the null hypothesis that the difference between the groupings would equal zero, the contrast was not statistically significant (p = .14). Therefore, neither H_4, H_5, nor H_6 related to the UARI performance measure were supported by the ANOVA or planned contrast analysis. The corresponding results of the ANOVA analysis used to test H_4, H_5, and H_6 are shown in Table 6.

Table 6

Analysis of Variance (ANOVA) for the Utilization of Average Resources Index (UARI)

	df	F	P value	η	Power
Communication Mode	2	1.63	.20	.03	.34
Decision Mode	1	.13	.72	.00	.06
Comm. Mode X Dec. Mode	2	.12	.89	.00	.06
Within	99				
Total	104				

Note. Communication mode refers to face-to-face, instant messaging and videoconferencing teams.

Decision mode refers to consensus instructed versus not-instructed teams.

Utilization of Best-Member Resource Index

The utilization of best-member resource index (UBRI) measures a team's ability to utilize the resources of its best member. The UBRI is a degree of improvement or loss in team decision performance as compared to the performance of the team's best member. The UBRI was calculated by subtracting the team's error score from the best member's individual error scores obtained in phase 1. A between subjects 2 X 3 factorial analysis of variance (ANOVA) was conducted to establish if team performance as measured by the utilization of best-member resource index on the NASA decision task were statistically significantly different between communication mode (face-to-face, instant messaging, and videoconferencing), decision mode (consensus instructed, not-instructed) and the experimental cells. In this ANOVA analysis, the UBRI team scores served as the dependent variable.

The specific directional hypotheses tested by this 2 X 3 ANOVA analysis were:

H_7: The decision quality improvement of team performance over the team's best member is significantly greater in face-to-face teams than the instant messaging teams and video conferencing teams.

H_8: The decision quality improvement of team performance over the team's best member is significantly greater in consensus instructed teams than the not-instructed teams.

H_9: An interaction effect is evident in that the decision quality improvement of team performance over the team's best member is significantly greater in the face-to-face/consensus instructed teams than in all other conditions.

For the analysis of variance for utilization of best-member resource index, neither main effect nor the interaction approached statistical significance. Specifically, the UBRI mean scores were again in the predicted direction for communication mode, but the main effect for communication mode of the teams in the face-to-face (M = 4.21), instant messaging (M = 2.89), and videoconferencing (M = 1.20) conditions were not statistically significant ($F_{2,99}$ = .70, p = .49), η = .01 with power = .16.

To further test H_7, a Helmert planned contrast analysis comparing face-to-face teams to all other communication mode conditions was performed. The three conditions were divided into two groupings. Cell one (face-to-face) was one grouping and cells 2 and 3 (instant messaging and videoconferencing) were the second grouping. The contrast difference between was 2.20 (SE = 2.14). Compared to the null hypothesis that the difference between the groupings would equal zero, the contrast was not statistically significant at (p = .30).

The main effect for the UBRI decision mode means were in the predicted direction, but the mean UBRI performance scores of the teams in the consensus instructed condition (M = 3.77) versus the not-instructed condition (M = 2.04) was not statistically significant ($F_{1,99}$ = .67, p = .41), η = .00 with power = .13. The corresponding results of the ANOVA analysis used to test H_7, H_8, and H_9 are shown in Table 7.

Table 7

Analysis of Variance (ANOVA) for the Utilization of Best-Member Resource Index (UBRI)

	df	F	P value	η	Power
Communication Mode	2	.70	.49	.01	.16
Decision Mode	1	.67	.41	.00	.13
Comm. Mode X Dec. Mode	2	.36	.69	.00	.10
Within	99				
Total	104				

Note. Communication mode refers to face-to-face, instant messaging and videoconferencing teams. Decision mode refers to consensus instructed versus not-instructed teams.

The mean cell UBRI scores were also in the predicted direction. However, the interaction effect comparing the UBRI scores in the face-to-face/instructed condition (*M* = 6.11), face-to-face/not-instructed condition (*M* = 2.40), instant messaging/instructed condition (*M* = 2.67), instant messaging/not-instructed condition (*M* = 3.11), videoconferencing/instructed condition (*M* = 2.13), and videoconferencing/not-instructed condition (*M* = .27) were not statistically significant ($F_{2,99}$ = .36, *p* = .69), η = .00 with power = .10.

To further test H_9, a Helmert planned contrast analysis comparing face-to-face/instructed teams to all other conditions for the UBRI performance measure was conducted. The six conditions were divided into two groupings. Cell one (face-to-face/instructed) was one grouping and cells 2, 3, 4, 5, and 6 were the second grouping. The contrast difference between was 3.99 (*SE* = 2.68). Compared to the null hypothesis that the difference between the groupings would equal zero, the contrast was not statistically significant ($p = .14$). Therefore, neither H_7, H_8, nor H_9 related to the UBRI performance measure were supported by the ANOVA or planned contrast analysis.

Assembly Effect

The assembly effect (AE) is another measure of a team's ability to utilize the resources of its best member. The assembly effect measure is simply whether the assembly effect occurred or did not occur in a team. The assembly effect measure is determined by comparing the team's best member's score to the team's error score on the NASA decision task. If a team's score on the NASA decision task was lower (better) than the best member's score, then that team was coded as a one (1). If the team's error score was greater (worse) on the NASA decision task, then that team was coded as a zero (0). A Chi Square test of Independence was conducted to identify significant main and interaction effects on the frequencies of teams that achieved the assembly effect. The occurrence or lack of the occurrence of the assembly effect served as the dependent variable.

The specific directional hypotheses tested by the chi square test of independence analysis were:

H_{10}: The proportion of face-to-face teams achieving the assembly effect is significantly greater than that of the instant messaging teams and that of the video conferencing teams.

H_{11}: The proportion of consensus instructed teams achieving the assembly effect is significantly greater than that of the not-instructed teams.

H_{12}: An interaction effect is evident in that the proportion of face-to-face/consensus instructed teams achieving the assembly effect are significantly greater than in all other conditions.

The chi square analyses for the assembly effect neither main effect nor the interaction effect approached statistical significance. Specifically, the occurrence of the assembly effect was again in the predicted direction for communication mode; but, the main effect for communication mode of the teams in the face-to-face (64.1%), instant messaging (52.7%), and videoconferencing (46.7%) conditions were not statistically significant at χ^2 (2) = 2.22, p = .33.

To further test $H_{10,}$ a planned contrast analysis comparing face-to-face teams to all other communication mode conditions was conducted. The three conditions were divided into two groupings. Cell one (face-to-face) was one grouping and cells 2 and 3 (instant messaging and videoconferencing) were the second grouping. Contrary to the research hypothesis that the face-to-face teams would achieve the assembly effect at a significantly greater rate than the other communication mode conditions, the chi square test for independence analysis was not statistically significant at χ^2 (1) = 1.97, p = .16.

The occurrence of the assembly effect was again in the predicted direction for the decision mode main effect. Contrary to the predicted directionality, the main effect for the occurrence of the assembly effect in the decision mode condition was not statistically significant at χ^2 (1) = .25, p = .61. The frequency of occurrence of the assembly effect for the teams in the consensus instructed condition (57.7%) and the not-instructed condition

(52.8%) did not support the research hypothesis that the assembly effect would occur at a significantly greater rate in the instructed consensus teams.

The cell assembly effect frequencies were also in the predicted direction, but the interaction effect comparing the assembly effect frequencies in the face-to-face/instructed condition (73.6%), face-to-face/not-instructed condition (55%), instant messaging/instructed condition (55.55%), instant messaging/not-instructed condition (50%), videoconferencing/instructed condition (40%), and videoconferencing/not-instructed condition (53.33%) were not statistically significant at χ^2 (5) = 4.24, *p* = .51. The frequency of teams achieving the assembly effect are shown in Table 8.

Table 8

Frequency of Teams Achieving the Assembly Effect Across all Conditions

	Assembly Effect		
Condition	Occurred	Did not occur	Total
Face-to-Face	25	14	39
Instant Messaging	19	17	36
Videoconferencing	14	16	30
Instructed Consensus	30	22	52
Not-instructed	28	25	53
Face-to-Face/Instructed	14	5	19
Face-to-Face/Not-instructed	11	9	20
Instant Messaging/Instructed	10	8	18
Instant Messaging/Not-instructed	9	9	18
Videoconferencing/Instructed	6	9	15
Videoconferencing/Not-instructed	8	7	15

To further test $H_{12,}$ a planned contrast analysis comparing face-to-face/instructed teams to all other conditions for the assembly effect measure was conducted. The six conditions were divided into two groupings. Cell one (face-to-face/instructed) was one grouping and cells 2, 3, 4, 5, and 6 were the second grouping. Contrary to the research hypothesis that the face-to-face/instructed teams would achieve the assembly effect at a significantly greater rate than the teams in all other conditions, the chi square test for independence analysis was not statistically significant at $\chi^2\,(1) = 3.19$, $p = .07$. Therefore, neither H_{10}, H_{11}, nor H_{12} as they relate to the assembly effect measure were supported by the chi square analyses or the consequent planned contrast analyses. The corresponding results of the chi square analysis used to test H_{10}, H_{11}, and H_{12} are shown in Table 9.

Table 9

Chi Square Test of Independence Comparing Frequency of Teams Achieving the Assembly Effect

	Assembly Effect		
Condition	df	X^2	P value
Communication Mode	2	2.22	.33
Communication Mode Planned Contrast	1	1.97	.16
Decision Mode	1	.25	.61
Comm. Mode X Dec. Mode (Interaction)	5	4.24	.51
Interaction Planned Contrast	1	3.19	.07

Note: $\alpha = .05$. Communication mode refers to face-to-face, instant messaging and videoconferencing teams.

Decision mode refers to consensus instructed versus not-instructed teams.

Multivariate Analysis of Variance (MANOVA)

The utilization of average resources index (UARI) measures a team's ability to utilize the resources of its members. As discussed previously, the UARI is a degree of improvement or loss in team decision performance as compared to the average performance of the team's members. The utilization of best-member resource index (UBRI) measures a team's ability to utilize the resources of its best member. As discussed previously, the UBRI is a degree of improvement or loss in team decision performance as compared to the performance of the team's best member. A 2 X 3 between subjects (two-factor) multivariate analysis of variance (MANOVA) was conducted to establish if team performance, as measured by the utilization of average resources index and the utilization of best-member resource index, on the NASA decision task were statistically significantly different between communication mode (face-to-face, instant messaging, and videoconferencing), decision mode (consensus instructed, not-instructed) and the experimental cells. In the MANOVA analysis, the UARI and UBRI team scores served as the dependent variables.

The specific directional hypotheses tested by the 2 X 3 MANOVA analyses were:

H_{13}: The decision quality improvement of team performance over the average performance of the team's members and the team's best member are significantly greater in face-to-face teams than the instant messaging teams and video conferencing teams.

H_{14}: The decision quality improvement of team performance over the average performance of the team's members and the team's best member are significantly greater in consensus instructed teams than the not-instructed teams.

H_{15}: An interaction effect is evident in that the decision quality improvement of team performance over the average performance of the team's members and the team's best member is significantly greater in the face-to-face/consensus instructed teams than in all other conditions.

For the multivariate analysis of variance for utilization of average resources index and utilization of best-member resource index, neither main effect nor the interaction was statistically significant at $\alpha = .05$. Specifically, the two-way MANOVA did not reveal a statistically significant main effect for communication mode (face-to-face vs. instant messaging vs. videoconferencing), Wilks' $\lambda = .937$, ($F_{4,98} = 1.63$, $p > .05$), $\eta = .032$. Power to test the effect was .496. The communication mode independent variable has three levels when comparing the first discriminate function to all others; therefore, it was appropriate to also use the Roy's Largest Root criteria. The Roy's Largest Root = .053, ($F_{2,99} = 2.64$, $p > .05$), $\eta = .051$ with power at .514. Again, the main effect for communication mode was not statistically significant per the Roy's Largest Root criteria, but the results were marginally significant at $p = .076$.

To further test $H_{13,}$ a Helmert planned contrast analysis comparing face-to-face teams to all other communication mode conditions was conducted. The three conditions were divided into two groupings. Cell one (face-to-face) was one grouping and cells 2 and 3 (instant messaging and videoconferencing) were the second grouping. The contrast difference between for the UARI performance measure was 3.13, (*SE* = 1.83). Compared to the null hypothesis that the difference between the groupings would equal zero, the contrast was not statistically significant at (p = .09). The contrast difference between for the UBRI performance measure was 2.21, (*SE* = 2.14). Compared to the null hypothesis that the difference between the groupings would equal zero; the contrast was not statistically significant at (p = .30). Therefore, H_{13} was not supported by the multivariate test results.

The two-way MANOVA also did not reveal a statistically significant main effect for decision mode (consensus instructed vs. not-instructed), Wilks' λ = .991, ($F_{2,98}$ = .456, p > .05), η = .009. Power to test the effect was .12. Consequently, H_{14} was not supported by the multivariate test results.

The two-way MANOVA did not show a significant interaction effect for the UARI and UBRI performance measure for the six experimental conditions (face-to-face/instructed, face-to-face/not-instructed, instant messaging/instructed, instant messaging/not-instructed, videoconferencing/instructed, and videoconferencing/not-instructed), Wilks' λ = .920, ($F_{10, 196}$ = .835, p > .05), η = .041. Power to test the effect was .434. The interaction variable has six levels and compares the first discriminate function to all others; therefore, it was appropriate to also use the Roy's Largest Root criteria. The Roy's Largest Root criterion was not statistically significant. The Roy's Largest Root = .057, ($F_{5,99}$ = 1.134, p > .05), η = .054 with power at .388. The corresponding results of the MANOVA analysis used to test H_{13}, H_{14}, and H_{15} are shown in Table 10.

Table 10

Multivariate Analysis of Variance (MANOVA) Results for the Utilization of Average Member Resources Index (UARI) and Utilization of Best-Member Resource Index (UBRI)

	df	Test Value	F	P value	η	Power
Communication Mode						
Wilks' λ	4	.937	1.63	.168	.032	.496
Roy's Largest Root	2	.053	2.64	.076	.051	.514
Decision Mode						
Wilks' λ	2	.991	.456	.635	.009	.122
Roy's Largest Root	N/A	N/A	N/A	N/A	N/A	N/A
Comm. Mode X Dec. Mode						
Wilks' λ	4	.992	.209	.933	.004	.094
Roy's Largest Root	2	.008	.418	.660	.008	.116

Note. Communication mode refers to face-to-face, instant messaging and videoconferencing teams.

Decision mode refers to consensus instructed versus not-instructed teams.

To further test $H_{15,}$ a Helmert planned contrast analysis comparing face-to-face/instructed teams to all other conditions for the UARI and UBRI performance measures was conducted. The six conditions were divided into two groupings. Cell one (face-to-face/instructed) was one grouping while cells 2, 3, 4, 5, and 6 were the second grouping. The contrast difference between for the UARI performance measure was 3.41, (SE = 2.29). Compared to the null hypothesis that the difference between the groupings would equal zero, the contrast was not significant at (p = .14). The contrast difference between for the UBRI performance measure was 3.99, (SE = 2.68). Compared to the null hypothesis that the difference between the groupings would equal zero, the contrast was not statistically significant at (p = .14). Therefore, H_{15} was not supported by the multivariate test results.

As a result of the MANOVA analyses, neither H_{13}, H_{14}, nor H_{15} in relation to the UARI and UBRI performance measures were supported by the MANOVA or the planned contrast analysis. Given the fact that neither main effect nor the interaction effect had significant omnibus F scores, as part of the MANOVA, an examination of the univariate results was not necessary (Keppel, 1991). The results of the Univariate tests are provided in Table 11.

Table 11

Multivariate Analysis of Variance Univariate Results for the Utilization of Average Member Resources Index (UARI) and Utilization of Best-Member Resource Index (UBRI)

	df	F	P value	η	Power
			UARI		
Communication Mode	2	1.63	.20	.03	.33
Decision Mode	1	.13	.71	.00	.06
Comm. Mode X Dec. Mode	2	.11	.89	.00	.06
Within	99				
			UBRI		
Communication Mode	2	.70	.49	.01	.16
Decision Mode	1	.67	.41	.00	.13
Comm. Mode X Dec. Mode	2	.36	.69	.00	.10
Within	99				
Total	104				

Note. Communication mode refers to face-to-face, instant messaging and videoconferencing teams.

Decision mode refers to consensus instructed versus not-instructed teams.

Summary

The preliminary analysis found the consensus instructions were effective in reducing non-consensus techniques (voting, averaging and trading) during the team NASA decision task in the consensus instructed teams vs. the not-instructed teams. An analysis of interrater agreement was also conducted. The analysis found a high degree of interrater agreement for averaging and trading among the teams; but, there was a relatively low degree of interrater agreement for majority voting among the teams as compared to the other non-consensus techniques.

The primary analysis tested a series of directional main and interaction effect hypotheses related to several measures of team performance on the NASA decision task. Although the analyses found no statistically significant support for either main effect hypotheses or the interaction hypotheses at $\alpha = .05$, the means for several of the team performance measures were in the predicted direction and some performance measure analysis did obtain results with $p < .10$. Specifically, the contrast analysis for the UARI performance measure for the communication mode main effect was marginally significant at $p = .09$, the contrast analysis for the assembly effect performance measure for the interaction effect was marginally significant at $p = .07$, and the multivariate communication mode main effect had a Roy's Largest Root marginally significant value of $p = .076$. Possible explanations for the results of this study will be explored in detail in Chapter 5.

CHAPTER FIVE – DISCUSSION

Introduction

This chapter is divided into three main sections. The first section reviews the methodology used to collect the research data, the results of the data analysis and conclusions drawn from the data. In the second section the implications of the research findings as compared to prior related research is discussed. The final section will focus on a discussion of the importance and implication of the research findings as they relate to business practice and recommendations for future research based on the limitations of this research study.

Methodology, Research Results and Conclusions

The major topic addressed in this study was to establish what combination of factors either contributed to, or possibly inhibited, the occurrence of process gain (the assembly effect) or process loss in decision-making teams. The present study sought to build upon the systematic development of previous studies in small-group research on group decision quality. Specifically, does consensus instruction affect team decision quality? Does the type of virtual technology-mediated communication used affect team decision quality? Does the effect of consensus instruction on team decision quality depend on the type of virtual communication mode used? Additionally, this study sought to demonstrate that teams in face-to-face communication environments would make higher quality decisions on a complex decision task than teams in internet-mediated communication environments.

Team Formation and Preliminary Analysis

In Phase one of the study, students from mainly Introduction to Marketing and Introduction to Management courses were instructed to visit a website to fill-out a short demographic survey and complete the NASA decision task. Four hundred and ninety-five students successfully completed the survey and individual decision task. Subjects were randomly assigned to a four-person team. A stratified random sampling procedure was used to create as many teams as possible that included at least one member of each gender. More males than females participated in the study; therefore, a concession was made to include nine teams that only consisted of one gender.

Two between subjects factors were used to randomly assign participants to their respective teams. The first factor was decision mode. The second factor used to assign teams was communication mode. Due to persistent scheduling issues of subjects in the experimental phase of the study another concession was made; if at least three members of the four-member team showed-up at the team's scheduled session time for the study, the subjects were asked to complete the NASA decision task with the team members present. If only two subjects showed, those subjects were usually placed back into the subject pool and reassigned to new teams. This resulted in a total of 105 teams completing Phase two of the study, with 62 three-person teams (59%) and 43 four-person teams (41%).

Before testing the study hypotheses, an analysis of the demographic information collected in Phase I was completed to describe the population of subjects in this study. Additional preliminary analysis was conducted to determine the effectiveness of treatment on the team's use of non-consensus decision-making techniques. An

Independent Sample T-test determined that the teams that received instruction in the consensus decision mode, before being asked to work together on the decision task, used non-consensus techniques such as voting, averaging, and trading to obtain a team solution statistically less often than the teams that did not receive instructions. The results found for effectiveness of treatment were consistent with Waugh's (1996) and Stapleton's (2006) research; but, caution in interpreting these results is necessary as the data was gathered through a self-report measure rather than through a true qualitative analysis of the team's communication process.

Interrater agreement was also assessed through the self-report decision style questionnaire, which was completed by each member of the team individually after completing the NASA decision task. The results on the analysis of interrater agreement were mixed; a relatively high percentage of team members agreed on the frequency of averaging and trading, but only 56.7% of the team members agreed on the frequency of majority voting. Since the decision style questionnaire is a self-report measure, it is possible that these results were skewed by the lack of understanding of what behaviors constitute the "majority voting" decision-mode process by the individual team members.

Primary Data Analysis

The primary data analysis consisted of a 2 X 3 between subjects factorial design. Several hypotheses were tested by comparing one mean individual performance measure and four mean team performance measures among teams differing in communication mode (face-to-face, instant messaging, and videoconferencing) and decision mode (consensus instructed vs. not-instructed). The data collected was analyzed in SPSS using descriptive statistics, inferential statistics, univariate statistics, multivariate statistics and when appropriate nonparametric tests.

As discussed in previous sections, in Phase one of the study the subjects were asked to complete the NASA decision task on their own. In Phase two of the study, subjects completed the NASA task again, but this time working together in their assigned teams. Naturally, the first question to ask is, “Did the teams score significantly better (lower) on the NASA decision task than the individuals did on their own?” Yes, the mean individual error score (IES) was 52 while the mean team error score (TES) on the NASA decision task was lower at 38. The mean error score difference was significant at $t\ (104) = -16.37$, $p < .01$. To a researcher the more interesting question is “Why did the teams perform better than the individuals?” This research attempted to answer that question by continuing lines of research based on team communication mode and team decision mode.

To summarize, none of the proposed hypotheses in this study were supported statistically by the data analyses in this study at $\alpha = .05$. Some hypotheses were supported by the directionality of the results, and some of the hypotheses results did reach marginal significance with $p < .10$. The results of the study are discussed in detail below by the three major factors upon which the study was based: team communication mode, team decision mode and the interaction between the two.

Communication Mode

The hypotheses related to the team communication mode main effect (face-to-face, instant messaging, and videoconferencing) were not statistically significant according to the data in this study at $\alpha = .05$. Interestingly, the hypotheses for the communication mode main effect data were in the predicted direction; the mean performance measures were in the predicted direction for all four team performance measures (team error score, UARI, UBRI and the assembly effect). Specifically, H_1, H_4, and H_7 were in the predicted direction on the mean performance measures of the team error score, the UARI and the UBRI respectively. Additionally, the proportion of teams that achieved the assembly effect was the highest (64.1%) in the face-to-face teams supporting H_{10}.

As mentioned above, some of the results did reach marginal significance. For the communication mode main effect, the Helmert planned contrast analysis as part of the ANOVA analysis for H_4 comparing the mean UARI scores of the face-to-face teams to a grouping of the instant messaging and videoconferencing teams was marginally significant at $p = .09$. Additionally, the MANOVA analysis for H_{13} comparing the mean UARI and UBRI scores did obtain marginal significance as measured by the Roy's Largest Root criteria with $p = .076$. The results of the communication mode main effect hypotheses were not supported statistically, but the directionality of the results and the marginal significance of some of the results suggest that the theoretical foundation for the related hypotheses are still intact. A further analysis of why the results were not as expected will be discussed in the following sections of this paper.

Decision Mode

The hypotheses related to the team decision mode main effect (consensus instructed vs. not-instructed) were also not statistically significant according to the data analyses in this study at $\alpha = .05$. Three of the hypotheses (H_5, H_8 and H_{11}) for the decision mode main effect were in the predicted direction. Specifically, the team performance measures on the UARI, the UBRI and for the assembly effect, all had results in the predicted direction. Interestingly, for the ANCOVA analysis for H_2, not-instructed teams actually had slightly lower (better) team error scores than the consensus instructed teams. For the MANOVA analysis of H_{14}, the Wilk's λ multivariate statistic was not significant indicating no directional relationship between team UARI and UBRI scores for teams in the consensus instructed condition. Directionality of three of the performance measures in support of the consensus instructed decision mode does indicate that the theoretical foundation for the use of consensus training still has some merit. These findings will be explored more thoroughly in later sections of the discussion.

Interaction Effect

The hypotheses which explored the relationship between the interaction of communication mode and decision mode, again were not statistically significant according to the data analyses at $\alpha = .05$. Similar to the communication mode main effect, the interaction effect between communication mode and decision mode hypotheses was supported directionally by the data; generally the mean performance measures were in the predicted direction for all four team performance measures (team error score, UARI, UBRI and the assembly effect). Specifically, H_3, H_6, and H_9 had data in the predicted direction of the mean performance measures of the team error score, the UARI and the UBRI respectively. Additionally, the proportion of teams that achieved the assembly effect was the highest (73.6%) in the face-to-face/instructed teams supporting H_{12}. For the MANOVA analysis of H_{15} interaction, the Wilk's λ multivariate statistic was not significant indicating no relationship between team UARI and UBRI scores for teams in the six experimental conditions.

As mentioned previously, some of the results did reach marginal significance. For the interaction effect, a Helmert planned contrast analysis as part of the chi square analysis for H_{12} comparing the frequency of the assembly effect of the face-to-face/instructed consensus teams to a grouping of the teams in the other five experimental cells was marginally significant at $p = .07$. In fact, 73.6% of the teams in the face-to-face/instructed consensus condition achieved the assembly effect.

There were two anomalies in the interaction effect data that was not consistent with the majority of the data. First, the instant messaging/not-instructed teams actually had a better mean team error score and a better mean UBRI score than the face-to-face/not-instructed teams. Second, the videoconferencing/instructed consensus teams represented the only condition that had less than 50% of its teams obtaining the assembly effect, with only 40% of the teams in that condition obtaining the assembly effect.

The results of the interaction effect hypotheses were not supported statistically, but the directionality of the results and the marginal significance of one of the contrast results suggest that some of the theoretical foundation for the related hypotheses may still have value. A further analysis of why the hypotheses results were not as predicted will be discussed in the following sections of this paper.

Implications of Research Findings Compared to Past Research

Decision Mode Main Effect

In this study, a series of directional main effect hypotheses looking at the impact of the decision mode condition (consensus instructed vs. not-instructed) using four performance measures of team performance on the NASA decision task were tested. None of the hypotheses related to the team decision mode main effect were statistically significant according to the data analyses. As stated previously, three of the hypotheses (H_5, H_8 and H_{11}) for the decision mode main effect were in the predicted direction. Specifically, the team performance measures on the UARI, the UBRI and for the assembly effect all had results in the predicted direction which was in line with the hypotheses for the decision mode main effect.

An initial 2 X 3 Analysis of Covariance (ANCOVA) using the team error scores (TES) as the dependent variable was conducted. To control for possible extraneous factors (confounding effects) between groups due to inequality of available member resources, the mean individual error scores (IES) and best member's error scores served as covariates. This study found that the mean individual error score was a statistically significant covariate with $p = .01$. Cooke and Kernaghan (1987) found that the average individual score accounted for 57% of the variance in team score and that the score of the best member significantly contributed to the team score, with both factors explaining 69% of the variance. Contrary to this research, Waugh (1996) found that only the mean best-member score was a significant covariate in determining the team error score on the NASA decision task. Stapleton's (2006) research did not find that the IES or the best-member score significantly affected the team's score, but the Winter Survival Task was used in Stapleton's study.

The present study failed to demonstrate that teams instructed in consensus were significantly better than not-instructed teams on the NASA decision task. This was consistent with Stapleton's (2006) research, but was not consistent with Waugh (1996) and Nemiroff and King (1975).

This study also was not able to demonstrate that consensus instructed teams were better able to use and integrate individual member resources. The results of the study failed to show statistically significant results for the utilization of average member resources or utilization of best member resource based on decision mode. Again, this was consistent with Stapleton (2006), but not consistent with the findings in Waugh (1996) and Nemiroff and King (1975). This result is a bit puzzling considering the effectiveness of treatment analysis showed that teams in the instructed consensus condition self-reported through the decision-styled questionnaire using voting, averaging and trading significantly less than the teams in the not-instructed decision mode condition. A possible explanation may lie in the fact that the percentage of interrater agreement on the use of non-consensus decision techniques was not as high in this study as in Waugh's (1996) and Stapleton's (2006) research. Additionally, teams could have used another decision technique, which was not listed on this study's questionnaire.

Stapleton (2006), Waugh (1996), and Nemiroff and King (1975) successfully demonstrated that consensus instructions statistically significantly influenced team achievement of the assembly effect. This study was not able to replicate those findings and did not find that the instructed consensus teams were able to achieve the assembly effect at a significantly greater rate than not-instructed teams.

Communication Mode Main Effect

Several studies have compared the performance of traditional teams and virtual teams with mixed results (Powell, et al., 2004). The results regarding outcomes can at best be described as mixed. In part, this is based upon the nature of the tasks and the types of virtual teams studied (Martins, et al., 2004). Some have found that virtual teams could not outperform traditional teams (Andres, 2006; Driskell, et al., 2003; McDonough, et al., 2001), while the majority of studies found no differences between the two types of teams (K. Burke & Aytes, 1998; K. Burke & Chidambaram, 1996). Additionally, most researchers have found no significant differences between traditional teams and computer-mediated teams when using decision quality as the performance measure (Archer, 1990; Chidambaram & Bostrom, 1993) or when decision tasks were used (Hollingshead, McGrath, & O'Connor, 1993).

The results of this study are consistent with most of the past relevant research in that no statistically significant communication mode main effect results were found between the face-to-face, instant messaging and videoconferencing teams. Specifically, face-to-face teams did not statistically outperform their counterpart teams as measured by the team error score, the utilization of average resources index, the utilization of best member resource index or the assembly effect on the NASA decision task in the instant messaging and videoconferencing conditions. Similarly, Potter and Balthazard (2002) found that the UARI and the UBRI scores of virtual teams were similar to those of their face-to-face counterparts on the dessert survival task.

However, the data in this study was consistent with the hypotheses for the communication mode main effect with directional results on the four decision task performance measures (TES, UARI, UBRI and the assembly effect). This was also consistent with Potter and Balthazard (2002) who found directional results for the team error scores and the UARI. Potter and Balthazard did find significant differences between face-to-face teams and virtual teams for synergy (assembly-effect). This study did not demonstrate a significant difference between face-to-face teams, instant messaging teams and videoconferencing teams; but, the proportion of teams that achieved the assembly effect was the highest (64.1%) in the face-to-face teams.

Baker (2002) found that the addition of video resources resulted in significant improvements to the quality of a team's decisions. This study does not support the prior research in this respect, the videoconferencing condition mean scores for the TES and UBRI performance measures were worse than the instant messaging teams and the video conferencing teams achieved the assembly effect less than the instant messaging teams.

Interaction between Decision Mode and Communication Mode

Much of the literature on virtual teams has been devoted to examining the effects of virtual interaction on team affective outcomes and on performance outcomes (such as effectiveness, speed of decisions, and decision quality). A line of research exists that focuses on how the technology medium affects virtual team outcomes. A narrow line of research exists which does focus on the use of training and decision techniques such as consensus on virtual team performance. Unfortunately, little research exists that has focused on the joint effects of both team communication mode and team decision mode on group decision quality as measured by the four performance measures used in this study. As mentioned above, the research findings on virtual team outcomes have been mixed.

The type of technology used by virtual teams is an important input as media richness (Daft & Lengel, 1984) has been found to positively influence team effectiveness, efficiency, and amount of communication (Carlson & Zmud, 1999; May & Carter, 2001). In contrast, the novelty of the technology used has been found to negatively impact team performance (Hollingshead et al., 1993). In a study examining the interaction between task type and communication medium, Straus and McGrath (1994) found that the overall effectiveness of computer-mediated groups was lower than that of face-to-face groups. Contrary to these results, Kayworth and Leidner (2000) found that rich computer-mediated communication systems "greatly facilitated teams" abilities to plan, to exchange ideas, and to reach consensus. Additionally, Schmidt et al. (2001) found that teams make more effective decisions than individuals, and virtual teams made the most effective decisions.

This research was not able to find a statistically significant interaction effect between group decision mode (instructed consensus vs. not-instructed) and communication mode (face-to-face, instant messaging, and videoconferencing) teams for decision quality. None of the univariate or multivariate analyses showed significant interaction effects for decision mode and communication mode on decision quality for any of the four team performance measures (team error score, UARI, UBRI, and the assembly effect). Similar to Potter and Balthazard's (2002) study, the data in this study was in the predicted direction for the interaction between decision mode and communication mode. The face-to-face/instructed groups had the best (highest) mean team error score and the best (lowest) UARI and UBRI scores for the NASA decision task. Additionally, the face-to-face/instructed teams were able to obtain the assembly effect at a greater rate, with 14 of the 19 teams (73.6%) obtaining the assembly effect. The results of this study appear to be most consistent with more recent findings that have shown virtual teams did not perform as well as face-to-face teams (Andres, 2006; Driskell, et al., 2003; McDonough, et al., 2001).

Impact of Research Findings and Suggestions for Future Research

Several researchers have commented that despite the prevalence of interest in virtual teams, there is a lack of clarity on what we know and the direction that future research should take (B. S. Bell & Kozlowski, 2002; Griffith & Neale, 2001). This research attempted to bring together different lines of research on virtual teams to gain a better understanding of what factors moderate team decision quality. It is still uncertain from the results of this study how consensus instruction and virtual communication mediums work together to moderate group performance, specifically decision quality. The impact of the results of this research study on virtual team performance research is unclear and discussed in more detail below.

In an attempt to increase internal validity certain concessions, limitations and delimitations can confound the data and jeopardize the external validity of the results of the study. Therefore, caution should be exercised in attempting to generalize the results of this study to "real-life" working virtual teams. The restrictions placed on this research study are discussed in an effort to better understand the results, the possible impact of these results on businesses and HR practice, and the continued need for future research on virtual teams.

The study was designed in such a way as to allow the ability to interpret the results obtained in this study to past results obtained in previous studies; therefore, it was deemed necessary to replicate some of the procedures and treatments of past studies. Except for the two phase data collection process used in the study, much of this study did replicate past study designs, specifically, the use of the NASA decision task, the team performance measures used to measure decision quality, consensus instruction, the three communication conditions (face-to-face, instant messaging and videoconferencing), ad hoc teams, small teams (3 to 4 members), and a convenience sample obtained from a college student population.

The fact that research lines exist that study specifically team task type, different measures of team performance, team decision modes, team communication modes, team communication processes, intact vs. ad hoc teams, face-to-face vs. virtual teams, and the number of team members impact on team performance, all speak to the fact that this research is current, relevant and needed.

Group decision tasks such as the NASA decision task have been used frequently in past small group decision research (Bottger & Yetton, 1988; Hall & Watson, 1971; Nemiroff & King, 1975; Waugh, 1996). The NASA decision task is considered a complex task, but this task does not mirror the often multi-layer complexity of tasks that face work teams. The NASA decision task has one correct answer; again, this is not true of most decisions that face "real-life" teams. Future research should incorporate decision tasks that are more consistent with the problems and decisions that are typically faced by teams in organizational environments (Hertel, et al., 2005).

The results of this study and of Stapleton's study (2006) question the premise that teams instructed in consensus promote the freedom of communication necessary to reach consensus. While teams claimed to use nonconsensus decision techniques less, as measured by the decision style questionnaire, consensus instructed teams were not able to statistically significantly improve decision quality or obtain the assembly effect at a statistically significant higher rate. Interestingly, Stapleton's study and this study did use a two-phase data collection process. It is possible that the subjects had difficulty remembering how they had individually scored the decision task, making effective sharing of unique information and spirited discussion during the team session less likely. This would result in a decrease of diverse inputs that could confound a team's efforts to reach consensus.

It is also possible that the consensus instructions themselves actually influenced the behavior of the team members in an unattended way. In an effort to avoid conflict, team members may have avoided giving differing opinions and viewpoints thus, limiting the sharing/pooling of information needed for teams to achieve higher quality decisions (Steiner, 1972). In light of these results, for future research it may be necessary to change the consensus instructions and incorporate qualitative performance measures to analyze the team communication process.

While the team performance measures (team error score, UARI, UBRI and assembly effect) used in the study are consistent with those used by past researchers that have used survival decision tasks; much research on team decision performance has also looked at team process measures such as the team's perception of the quality of their decision, the team's satisfaction with the teams decision, team trust and the likelihood that the team's members would want to work together again. Future research on team decision quality should use both team process and team outcome measures of group performance.

Much team performance research has primarily used undergraduate student populations (Martins, et al., 2004) as study participants (as did this research). As with many university studies, the students were incentivized to participate in the study through the opportunity to earn extra credit and an opportunity to receive randomly drawn gift cards. Individual team member's motivations are an important element of team performance. Subjects were not incentivized to do well on the decision task, but rather incentivized to complete the decision task. A student's lack of motivation to perform on the individual task or the team task could easily confound the results of this study. It is not clear that university undergraduate students are a reliable source for team performance research. While university student populations are convenient for team-based research, an effort needs to be made to use organization-based populations who are vested in the results of their teams (Martins, et al., 2004).

This study used a convenience sample of undergraduate students who were randomly assigned to teams. Past research using university populations on team decision performance traditionally used ad hoc teams. Similarly, the teams in this study were formed solely to complete the task, and then the teams were disbanded. While many of the subjects will have had some prior history together, it is unlikely that subjects in this study had worked in virtual team environments with their peers previously or would be required to work together in the future on a team in a face-to-face or virtual environment. Therefore, there were no real rewards or negative consequences associated with the team's performance on the decision task. For many of the teams, their primary concern may have been successful completion of the task, not the quality of the team's decision. In a study that examined group history, by Alge et al. (2003), no differences were found in communication effectiveness or information sharing for groups that had a prior history of working together. It is uncertain how previous relationships or the lack of a future relationships by the team members may have affected the team's communication process and/or the team's decision quality in this study. More research should be conducted that compares team performance of intact versus ad hoc teams in the virtual environment.

Any communication medium has an inherent impact on communication. The theory of social presence (Short, Williams, & Christie, 1976) and media richness (Daft & Lengel, 1984) posit that the capacity to effectively transmit information (visual, verbal, and contextual cues) is progressively lost as communication moves from face-to-face to audio/video, to audio-only to text modes of communication. Much research has compared virtual team asynchronous vs. synchronous communication. Research has looked at face-to-face teams vs. teams that could only communicate in text-based communication environments. A line of research has compared face-to-face teams to teams in video conferencing environments. An issue with this research (this study included) is that rarely do organizational virtual teams work exclusively in one communication medium (Dasgupta, 2003). It is more likely that virtual teams use several different communication mediums in concert (phone, email, texting, and videoconferencing) while working on problems or making decisions. Future research looking at technology-mediated communication in virtual teams will need to allow teams to choose and use multiple communication mediums to allow for more generalization of the results to organizational work environments.

In this study, the two virtual environments were an instant messaging application (Microsoft Live Messenger™) and a videoconferencing application (ooVoo™). While most of the students had used an instant messaging application before and had been exposed to Internet video applications such as Skype, it is unlikely that the students had actively used these applications before in a virtual team environment to make decisions.

Hollingshead et al. (1993) found that team member performance could be affected negatively by the newness of the technology being used. Additionally, Kayworth and Leidner (2000) found that a lack of technical expertise had a negative effect on team performance. In light of the findings in past research, the results of this study may have been confounded by a lack of experience with these applications or the newness of these applications to the virtual team members.

Again, to be consistent with past research, this study chose to use three and four person teams. Almost all lab studies of virtual teams conducted using students have used teams that range in size from 3 to 5 members (Martins, et al., 2004). In corporate environments, virtual teams may approach 100 team members in size (Ahuja & Galvin, 2003). It is possible that the team sizes used in this study were not sufficiently large enough to allow the team to benefit from a diverse pooling of knowledge. Therefore, future research should look at the dynamics of the team decision process in larger teams that are more consistent with the corporate environment.

Management and HR Practice

Virtual teams are not a new phenomenon in the corporate environment, but our understanding of virtual teams is only now starting to take shape. In fact, the *Wall Street Journal* reported that more than half of the companies with more than 5000 employees used virtual teams in 1999. Given, that a major belief and benefit of virtual teams is their ability to draw the best expertise regardless of where it resides (Solomon, 2001), the results of this study are encouraging. If individual member inputs, a significant covariate in this study, are the most important factor to virtual team success, the fact that no significant difference in decision quality was found between face-to-face teams and the virtual teams (instant messaging and videoconferencing) then the premise for using virtual teams in corporate environments are in line with the results of this study.

Virtual teams have become an integral part of many organizations because of an increase in corporate restructuring, competition, and globalization (Baker, 2002). The global economy combined with the multinational corporate structures of businesses today necessitates the management practice of virtual teams if companies want to maximize their knowledge resources to address corporate issues. Overall, virtual teams provide an effective structural mechanism for handling the increased travel, time, coordination, and costs associated with bringing together geographically, temporally, and functionally dispersed employees to work on a common task (Martins, et al., 2004). The corporate challenge is to maximize and leverage the management practice of virtual teams to obtain organizational efficiencies, which lead to a corporate competitive advantage.

Given the virtual teams ability to transcend the traditional constraints of time, location, social networks, and organizational boundaries, virtual teams can enhance the competitive flexibility of organizations (Martins, et al., 2004). Human resource management strategies and procedures need to address the unique needs, issues and problems virtual teams create in the corporate environment in order to obtain these corporate competitive advantages. Many of these issues go beyond the scope of this study, but a few generally related to this study are discussed below.

Companies that can effectively harness and use virtual teams will obtain or maintain a competitive advantage. Human resource professionals can assist their organizations in the creation and maintenance of effective virtual teams in many ways. First, a knowledge database should exist within organizations that allow management to form virtual teams that are diverse in technological knowledge, task specific knowledge and cultural issues to pool appropriate knowledge to address complex business issues. Second, human resource professionals need to be adept at attracting, hiring and incentivizing individuals to work in virtual team environments. Third, human resource professionals should develop and effectively deliver training on communication technologies, and on appropriate and effective communication techniques within the virtual team environment. Fourth, human resource management should be involved in the corporate strategy related to when and how best to utilize virtual teams to address pressing organizational problems. Lastly, human resource professionals can stay abreast of the current research knowledge on virtual teams and assist academicians in gaining access to their organizations to allow more field study research on virtual teams.

Despite the level of research interest in virtual teams, there is still uncertainty in relation to an integrated set of factors that contribute to virtual team effectiveness (Lin, et al., 2008). The present research study has contributed to the body of knowledge, which exists to gain a better understanding of the conditions that influence virtual team decision performance. This research has combined theoretical foundations of small group research, information technology research, communication research, and virtual team research with an empirical research design in an attempt to understand virtual team decision quality. Specific contributions include the comparison of two synchronous virtual communication modes (instant messaging and videoconferencing) versus face-to-face teams in one study. Additionally, this study examined both decision mode and communication mode at the same time to gain a better understanding of the possible interaction between consensus instruction and virtual communication mediums. Lastly, this research presented an additional multivariate MANOVA analysis in an attempt to gain a better understanding of how the dependent variables of average member resources and best member's resource my work together to affect team decision quality. While some knowledge was gained, many questions about team decision quality and virtual team communication remain. As stated by Martins, Gilson and Maynard (2004, p. 819), "Researchers are only now beginning to understand how virtual teams function, and much work remains to be done in order to facilitate the design and management of such teams".

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APPENDICES

APPENDIX A – INFORMED CONSENT FORM

Informed Consent Form

The Researcher conducting this study is Dennis Nasco, a Doctoral student at Southern Illinois University-Carbondale.

He is asking you and other students enrolled in Business Courses during the summer session to participate in this research study. The purpose of this research study is to determine if teams perform better than individuals on complex decision tasks regardless of the communication environment.

This research study has two phases. In the first phase, you will be asked to complete a brief demographic survey online, and then complete a decision task individually in an online environment. This normally takes less than 30 minutes to complete. In phase two, at a later time, you will be asked to work in a team to complete a decision task and a brief survey about your team's interactions during completion of the decision task. The 2nd phase normally takes approximately 30 to 45 minutes to complete.

Participation in both phases of this research study is voluntary. Completion of either or both phases of this study indicates voluntary consent to participate in the study.
In the second phase of the study, teams will be digitally videotaped via a computer webcam during the team's completion of the decision tasks. To maintain confidentiality, your name will not be attached to the video recording in anyway, just the teams identification number. Only those directly involved with this research project will have access to the videos. The digital videos will be stored in a locked cabinet and all videos will be destroyed at the end of the study.

All of your survey responses, individual decision task responses, and team decision task interactions and responses will be kept confidential within reasonable expectations and limits. Only those directly involved with this project will have access to the data. Your name will be removed from all data records after the results of each phase of the study have been recorded.

If you have any questions about this research study, please contact me or my advisor.

Dennis Nasco Researcher 618-453-2605 dnasco@siu.edu	Dr. Keith Waugh Associate Professor 618-453-4868 ckwaugh@siu.edu

You agree to participate in this research and know that your interactions in the second phase of this research study will be recorded on video. If you have read and understand the conditions of this research, and volunteer to participate, please sign below.

Name Date

This project has been reviewed and approved by the SIUC Human Subjects Committee. Questions concerning your rights as a participant in this research may be addressed to the Committee Chairperson, Office of Research Development and Administration, SIU, Carbondale, IL 62901-4709. Phone (618) 453-4533. E-mail: siuhsc@siu.edu.

APPENDIX B – INDIVIDUAL PHASE ONE INSTRUCTIONS

Individual (First) Phase Instructions

This research study is an experiment to determine if certain groups in different conditions perform better than individuals on complex decision tasks. The study consists of two short parts. The first part consists of the individual completion of the NASA Survival (Lost on the Moon) task and a short demographic survey.

Your instructor has agreed to give you extra credit points for either MGMT 304 or MKTG 304 if you complete both parts of this study.

To maintain the integrity of this research data, please do not interact or work with anyone while you are completing the exercises. Additionally, please do not share your responses with other students who could be a part of this research study.

1. Read the scenario instructions for the NASA Survival Exercise carefully before you complete this task by ranking the listed items.
2. Complete the short demographic survey first.
3. Select dates and times of your availability for the 2nd phase of this research study

Once you have completed the above, you will have completed Phase one of this research study. You will be contacted shortly to arrange a time to participate in phase two of this research study.

Thank you very much for assisting with this study.

APPENDIX C – GROUP PHASE INSTRUCTIONS

Group Phase Consensus-CM Instructions

This research study is an experiment to determine if certain groups in different conditions perform better than individuals on complex decision tasks. The study consists of two short parts. The first part, which you have already completed, consists of a short demographic survey and the individual completion of the NASA Survival (Lost on the Moon) Exercise. In the second phase of this pilot study, you will work in an internet mediated environment, as a group, to complete the same complex task as a team.

First, you will complete a 3 minute training session on group consensus. After completing the training, each of you will be taken to a separate room where you will use a laptop and an internet-mediated software program to interact with your other team members to complete the complex decision task together as a team. One of you will act as the team scribe and record the team's scores for the Survival Exercise. Once the team has completed the decision task rankings, please do not close your Internet communication session. The experimenter will close out the sessions to record the team's activities and decision task rankings.

Finally, please complete the three question Decision-Style Questionnaire and the short group interaction survey and submit before leaving the experiment area.

APPENDIX D – DEMOGRAPHIC SURVEY

Demographic Information

Name:________________________________ (Print)

Date of Birth (M/D/Y):_______________

Gender: M F

Major:___________________________

Class Standing: Freshman Sophomore Junior Senior

Graduate

Ethnicity: Caucasian/White African/Black
Latino/Hispanic

Asian Other:______________________
(Please Specify)

Highest Level of Degree Attainment: A.A./A.S. B.A./B.S.
M.S.

From Waugh, C.K. (1996). Joint effects of group composition and instruction in consensus-seeking on decision quality. *Dissertion Abstracts International, 57*(10), 43b. (UMI No. 9710972)

From Stapleton, J.L. (2006) Joint effects of team composition and team decision mode on complex decision quality. *Dissertation Abstracts International,* (UMI No. 3215030)

APPENDIX E – CONSENSUS INSTRUCTIONS

INSTRUCTIONS FOR REACHING CONSENSUS

The task on which you are about to begin involves group decision-making. Your group is to employ the method of Group Consensus in reaching its decision. This means that the prediction of each of the fifteen (15) ranks must be agreed upon by each group member before it becomes a part of the group decision.

Consensus is difficult to reach. Therefore, not every ranking will meet with everyone's complete approval. Try, as a group, to make each ranking one with which all group members can at least partially agree. Here are some guides to use in reaching consensus:

1. Avoid arguing for your own individual judgments.

2. Avoid changing your mind only in order to reach agreement and avoid conflict. Support only solutions with which you are able to agree somewhat at least.

3. Avoid "conflict-reducing" techniques such as majority vote, averaging, or trading in reaching decisions.

4. View differences of opinion as helpful rather than as a hindrance in decision making. Differences of opinion are natural and expected. Seek them out and try to involve everyone in the decision process.

5. Disagreements can help the group's decision because with a wider range of information and opinions, there is a greater chance that the group will hit upon more adequate solutions.

From Nemiroff, P. M. & King, D. C. (1975). Group decision-making performance as influenced by consensus and self-orientation. *Human Relations, 28,* 1-21.

APPENDIX F – DECISION-STYLE QUESTIONNAIRE

DECISION-STYLE QUESTIONNAIRE

Please read each question carefully before answering.

While our group was working together to solve the Winter Survival Exercise, our group voted on the ranking of items approximately _____ times. (Please fill in the blank with a number)

While our group was working together to solve the Winter Survival Exercise, our group averaged the rankings of members approximately _____ times. (Please fill in the blank with a number)

While our group was working together to solve the Winter Survival Exercise, group members traded rankings (i.e., compromised by giving up the wanted rank of an item in return for another item being ranked as wanted) approximately _____ times. (Please fill in the blank with a number)

From Waugh, C. K. (1996). Joint effects of group composition and instruction in consensus-seeking on decision quality. *Dissertation Abstracts International, 57*(10), 43b. (UMI No. 9710972).

APPENDIX G – NASA DECISION TASK AND RANKINGS

Lost on the Moon Worksheet
from NASA

Your spaceship has just crashed on the moon. You were scheduled to rendezvous with a mother ship 200 miles away on the lighted surface of the moon, but the rough landing has ruined your ship and destroyed all the equipment on board except for the 15 items listed below.

Your crew's survival depends on reaching the mother ship, so you must choose the most critical items available for the 200-mile trip.

Your task is to rank the 15 items in terms of their importance for survival. Place a number 1 by the most important item, number 2 by the second most important, and so on, through number 15, the least important.

_______ Box of matches

_______ Food concentrate

_______ 50 feet of nylon rope

_______ Parachute silk

_______ Solar-powered portable heating unit

_______ Two .45caliber pistols

_______ One case of dehydrated milk

_______ Two 100-pound tanks of oxygen

_______ Stellar map (of the moon's constellations)

_______ Self-inflating life raft

_______ Magnetic compass

_______ 5 gallons of water

_______ Signal flares

_______ First-aid kit containing injection needles

_______ Solar-powered FM receiver-transmitter

Hall, J. (1971). Decisions, decisions, decisions. *Psychology Today*, 51-54, 86, 88.

CORRECT RANKINGS

Lost on the Moon Worksheet
from NASA

15	Box of matches
4	Food concentrate
6	50 feet of nylon rope
8	Parachute silk
13	Solar-powered portable heating unit
11	Two .45caliber pistols
12	One case of dehydrated milk
1	Two 100-pound tanks of oxygen
3	Stellar map (of the moon's constellations)
9	Self-inflating life raft
14	Magnetic compass
2	5 gallons of water
10	Signal flares
7	First-aid kit containing injection needles
5	Solar-powered FM receiver-transmitter

Hall, J. (1971). Decisions, decisions, decisions. *Psychology Today*, 51-54, 86, 88.

APPENDIX H – COPYRIGHT PERMISSIONS

Copyright Permission for NASA "Lost on the Moon" Task

From: Kaja Perina [kaja@psychologytoday.com]
Sent: Wednesday, September 08, 2008 9:18 AM
To: Nasco, Dennis
Subject: Re: Permission to reprint??

That's fine, please just cite PT. Thank you.

Kaja Perina, editor in chief
Psychology Today
115 East 23rd Street
NYC 10010

tel: 212.260.7210 ext 234
fax: 212.260.7445

www.psychologytoday.com

On Sep 7, 2008, at 11:14 PM, Nasco, Dennis wrote:

Kaja:
I would like to use the NASA decision task in my dissertation research study.
Please advise.
Thank you,
Dennis

Sent from my Verizon Wireless BlackBerry

From: Kaja Perina <kaja@psychologytoday.com>
Date: Tue, 7 Sep 2008 20:15:01 -0500
To: Nasco, Dennis<dnasco@business.siuc.edu>
Subject: Re: Permission to reprint??

If this is for use in a course, then permission granted, if other, please specify and I'll let you know the options.
Best,
Kaja Perina, editor in chief
On Sep 7, 2008, at 6:35 PM, Nasco, Dennis wrote:

How can I obtain permission to reprint (use) the NASA "Lost on the Moon" decision task from *Decisions, decisions, decisions*, J. Hall, Psychology Today, (November, 1971).

Any assistance you can provide me would be greatly appreciated.

Regards,
Dennis Nasco, Jr.

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SAGE

Title:	Group Decision-Making Performance as Influenced by Consensus and Self-Orientation
Author:	Paul M. Nemiroff, Donald C King
Publication:	Human Relations
Publisher:	Sage Publications
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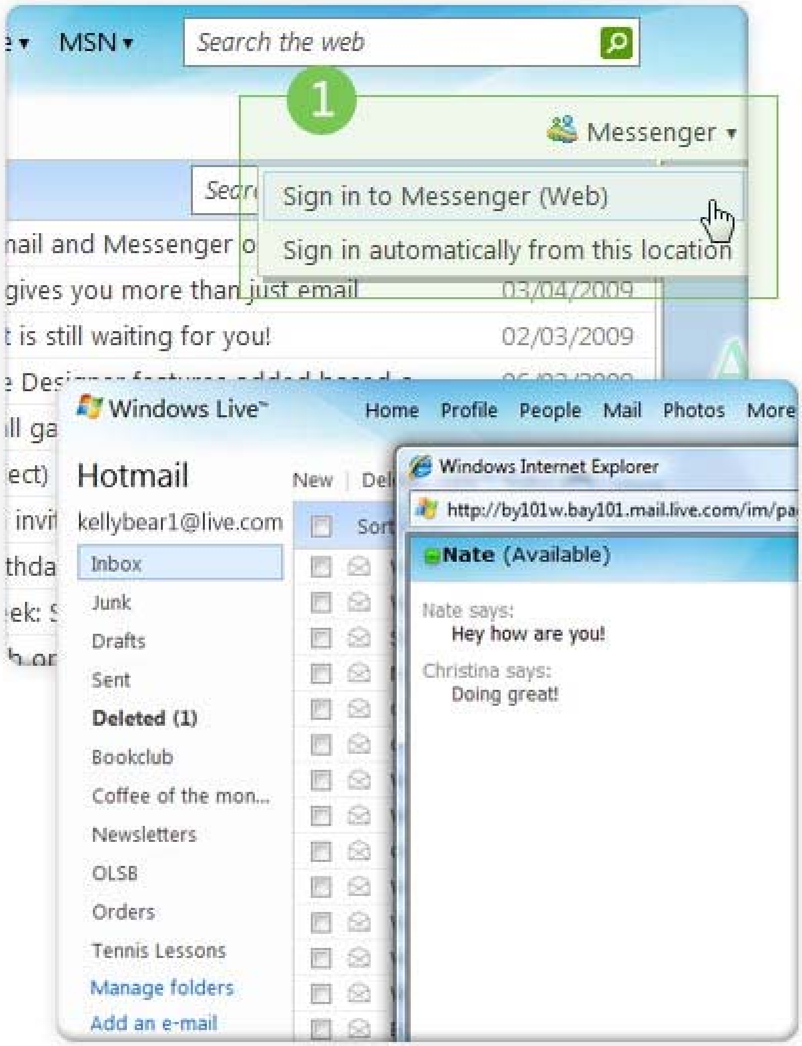
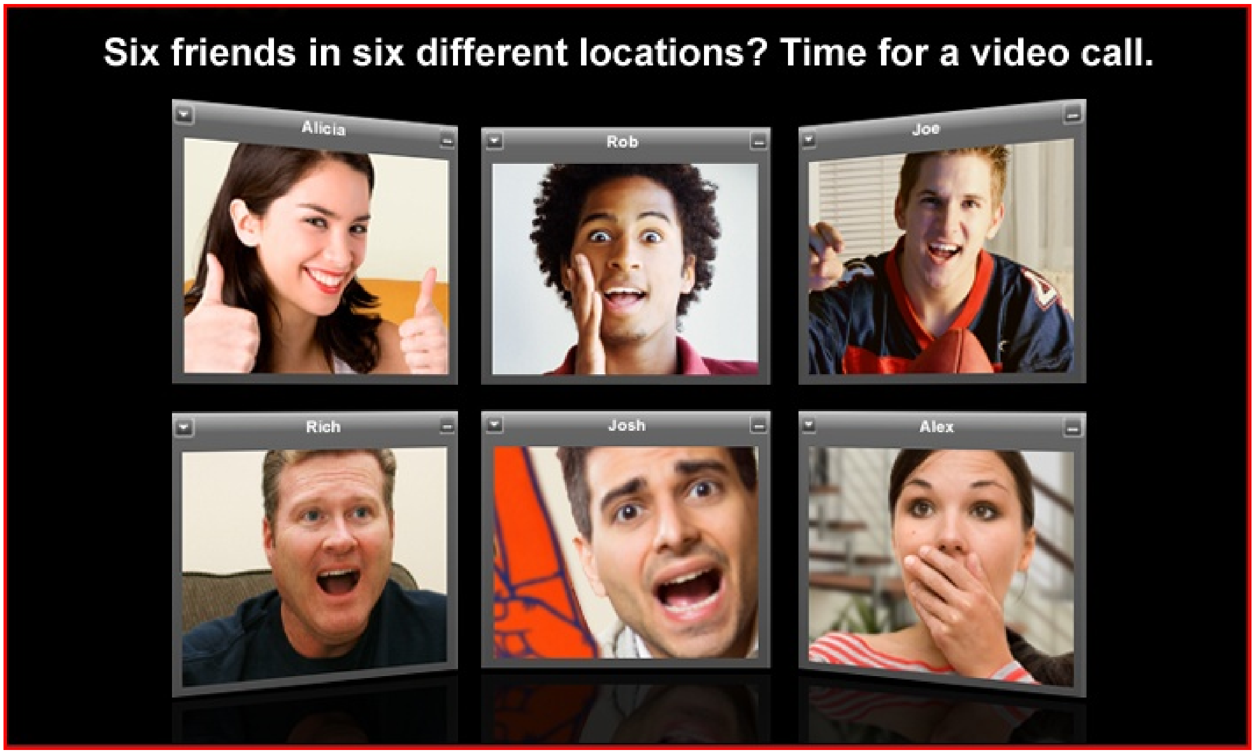
APPENDIX I – WINDOWS LIVE MESSENGER

Windows Live Messenger™ Screen Capture



APPENDIX J – OOVOO VIDEOCONFERENCING APPLICATION

ooVoo™ Screen Capture



APPENDIX K – PERFORMANCE MEASURE SCORES

Team # 1 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	56	56	42	14	-6	0
#2	86					
#3	46					
#4	36					

Team # 2 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	74	59.33	44	15.33	-2	0
#2	62					
#3	42					

Team # 3 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	52	56.67	42	14.67	10	1
#2	64					
#3	54					

Team # 4 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	60	50.67	30	20.67	4	1
#2	58					
#3	34					

Team # 5 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	36	54.67	30	24.67	6	1
#2	56					
#3	72					

Team # 6 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	70	56.5	40	16.5	8	1
#2	56					
#3	48					
#4	52					

Team # 7 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	52	50	30	20	0	0
#2	30					
#3	68					

Team # 8 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	58	51	30	21	-10	0
#2	50					
#3	20					
#4	76					

Team # 9 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	72	49	34	15	4	1
#2	38					
#3	40					
#4	46					

Team # 10 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	58	48.5	30	18.5	8	1
#2	38					
#3	48					
#4	50					

Team # 11 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	56	54	60	-6	-8	0
#2	54					
#3	52					

Team # 12 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	54	47.5	48	-0.5	-12	0
#2	40					
#3	60					
#4	36					

Team # 13 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	56	52.67	46	6.67	4	1
#2	50					
#3	52					

Team # 14 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	64	64.5	50	14.5	-2	0
#2	88					
#3	58					
#4	48					

Team # 15 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	62	65.5	46	19.5	10	1
#2	56					
#3	58					
#4	86					

Team # 16 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	42	55	42	13	0	0
#2	66					
#3	58					
#4	54					

Team # 17 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	62	50	22	28	18	1
#2	48					
#3	40					

Team # 18 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	46	53	32	21	14	1
#2	60					
#3	48					
#4	58					

Team # 19 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	52	48.5	30	18.5	-2	0
#2	50					
#3	64					
#4	28					

Team # 20 – F2F/Not-instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	58	45.5	28	17.5	4	1
#2	32					
#3	42					
#4	50					

Team # 21 – F2F/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	60	57.33	38	19.33	12	1
#2	62					
#3	50					

Team # 22 – F2F/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	64	56	38	18	-2	0
#2	36					
#3	68					
#4	56					

Team # 23 – F2F/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	72	54.5	54	0.5	-8	0
#2	46					
#3	46					
#4	54					

Team # 24 – F2F/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	32	38.67	20	18.67	10	1
#2	30					
#3	54					

Team # 25 – F2F/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	38	53.5	36	17.5	2	1
#2	60					
#3	48					
#4	68					

Team # 26 – F2F/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	52	46.67	26	20.67	12	1
#2	38					
#3	50					

Team # 27 – F2F/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	36	36.67	32	4.67	-2	0
#2	30					
#3	44					

Team # 28 – F2F/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	42	50.00	34	16.00	8	1
#2	58					
#3	50					

Team # 29 – F2F/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	48	51.5	22	29.5	22	1
#2	44					
#3	58					
#4	56					

Team # 30 – F2F/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	52	62.5	44	18.5	8	1
#2	76					
#3	58					
#4	64					

Team # 31 – F2F/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	46	54.5	30	24.5	16	1
#2	50					
#3	64					
#4	58					

Team # 32 – F2F/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	62	62.67	40	22.67	2	1
#2	42					
#3	84					

Team # 33 – F2F/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	58	62.67	40	22.67	18	1
#2	68					
#3	62					

Team # 34 – F2F/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	40	44.67	36	8.67	4	1
#2	44					
#3	50					

Team # 35 – F2F/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	74	67.33	48	19.33	2	1
#2	78					
#3	50					

Team # 36 – F2F/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	36	39.5	34	5.5	0	0
#2	34					
#3	36					
#4	52					

Team # 37 – F2F/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	62	57.5	52	5.5	-4	0
#2	62					
#3	58					
#4	48					

Team # 38 – F2F/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	60	65.5	30	35.5	14	1
#2	70					
#3	88					
#4	44					

Team # 39 – F2F/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	40	46	28	18	2	1
#2	30					
#3	44					
#4	70					

Team # 40 – IM/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	70	58.67	44	14.67	-2	0
#2	42					
#3	64					

Team # 41 – IM/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	40	47	24	23	16	1
#2	48					
#3	52					
#4	48					

Team # 42 – IM/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	44	36	38	-2	-12	0
#2	26					
#3	32					
#4	42					

Team # 43 – IM/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	54	46	38	8	-2	0
#2	36					
#3	48					

Team # 44 – IM/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	50	51	44	7	0	0
#2	44					
#3	50					
#4	60					

Team # 45 – IM/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	50	47.33	38	9.33	6	1
#2	48					
#3	44					

Team # 46 – IM/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	58	50	28	22	8	1
#2	56					
#3	36					

Team # 47 – IM/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	56	48.67	24	24.67	18	1
#2	48					
#3	42					

Team # 48 – IM/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	46	51.33	42	9.33	4	1
#2	52					
#3	56					

Team # 49 – IM/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	66	56.5	44	12.5	2	1
#2	60					
#3	46					
#4	54					

Team # 50 – IM/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	46	55.33	32	23.33	14	1
#2	56					
#3	64					

Team # 51 – IM/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	58	41	24	17	-2	0
#2	22					
#3	46					
#4	38					

Team # 52 – IM/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	44	43.33	36	7.33	-2	0
#2	52					
#3	34					

Team # 53 – IM/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	48	45.33	34	11.33	0	0
#2	54					
#3	34					

Team # 54 – IM/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	44	47.5	28	19.5	6	1
#2	54					
#3	58					
#4	34					

Team # 55 – IM/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	68	62.67	56	6.67	-2	0
#2	66					
#3	54					

Team # 56 – IM/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	58	54.67	38	16.67	12	1
#2	56					
#3	50					

Team # 57 – IM/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	62	48.67	46	2.67	-8	0
#2	38					
#3	46					

Team # 58 – IM/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	48	53.25	56	-2.75	-8	0
#2	65					
#3	54					
#4	46					

Team # 59 – IM/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	56	48.67	56	-7.33	-14	0
#2	48					
#3	42					

Team # 60 – IM/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	54	52	36	16	8	1
#2	58					
#3	44					

Team # 61 – IM/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	50	47	22	25	18	1
#2	52					
#3	40					
#4	46					

Team # 62 – IM/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	48	60.5	42	18.5	6	1
#2	48					
#3	84					
#4	62					

Team # 63 – IM/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	60	60	44	16	10	1
#2	54					
#3	60					
#4	66					

Team # 64 – IM/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	54	58.67	52	6.67	2	1
#2	62					
#3	60					

Team # 65 – IM/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	72	63.33	48	15.33	8	1
#2	56					
#3	62					

Team # 66 – IM/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	66	64	50	14	-4	0
#2	80					
#3	46					

Team # 67 – IM/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	42	42	32	10	-4	0
#2	28					
#3	56					

Team # 68 – IM/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	44	48	36	12	8	1
#2	50					
#3	50					

Team # 69 – IM/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	48	48	44	4	-6	0
#2	58					
#3	38					

Team # 70 – IM/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	56	59.33	24	35.33	32	1
#2	66					
#3	56					

Team # 71 – IM/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	58	53.33	38	15.33	-10	0
#2	74					
#3	28					

Team # 72 – IM/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	56	52.5	42	10.5	6	1
#2	48					
#3	58					
#4	48					

Team # 73 – IM/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	52	37.33	32	5.33	-18	0
#2	14					
#3	46					

Team # 74 – IM/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	44	48.67	24	24.67	20	1
#2	50					
#3	52					

Team # 75 – IM/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	66	54	48	6	-6	0
#2	42					
#3	54					

Team # 76 – Video/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	56	59.33	42	17.33	14	1
#2	62					
#3	60					

Team # 77 – Video/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	56	48	26	22	8	1
#2	54					
#3	34					

Team # 78 – Video/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	52	61.5	30	31.5	22	1
#2	66					
#3	62					
#4	66					

Team # 79 – Video/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	36	45.33	22	23.33	14	1
#2	50					
#3	50					

Team # 80 – Video/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	50	56.67	40	16.67	10	1
#2	62					
#3	58					

Team # 81 – Video/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	36	48.5	44	4.5	-8	0
#2	42					
#3	66					
#4	50					

Team # 82 – Video/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	66	56.5	38	18.5	2	1
#2	64					
#3	40					
#4	56					

Team # 83 – Video/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	66	50.67	48	2.67	-10	0
#2	48					
#3	38					

Team # 84 – Video/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	20	44.67	34	10.67	-14	0
#2	46					
#3	68					

Team # 85 – Video/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	58	53.33	44	9.33	-2	0
#2	60					
#3	42					

Team # 86 – Video/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	52	60.67	58	2.67	-6	0
#2	54					
#3	76					

Team # 87 – Video/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	42	54	38	16	4	1
#2	66					
#3	58					
#4	50					

Team # 88 – Video/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	40	47.33	42	5.33	-2	0
#2	52					
#3	50					

Team # 89 – Video/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	86	58.67	40	18.67	4	1
#2	44					
#3	46					

Team # 90 – Video/Not-Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	54	41	40	1	-32	0
#2	54					
#3	48					
#4	8					

Team # 91 – Video/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	42	44.67	24	20.67	18	1
#2	44					
#3	48					

Team # 92 – Video/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	36	48	54	-6	-18	0
#2	52					
#3	56					

Team # 93 – Video/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	56	54	24	30	18	1
#2	42					
#3	56					
#4	62					

Team # 94 – Video/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	66	56.5	50	6.5	0	0
#2	50					
#3	60					
#4	50					

Team # 95 – Video/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	48	56.5	38	18.5	10	1
#2	52					
#3	58					
#4	68					

Team # 96 – Video/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	48	46	40	6	-10	0
#2	30					
#3	60					

Team # 97 – Video/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	50	53.33	28	25.33	22	1
#2	54					
#3	56					

Team # 98 – Video/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	54	48.67	30	18.67	-4	0
#2	66					
#3	26					

Team # 99 – Video/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	68	54.67	50	4.67	-10	0
#2	40					
#3	56					

Team # 100 – Video/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	44	49.33	44	5.33	0	0
#2	52					
#3	52					

Team # 101 – Video/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	64	62	44	18	-10	0
#2	88					
#3	34					

Team # 102 – Video/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	48	53	26	27	20	1
#2	64					
#3	54					
#4	46					

Team # 103 – Video/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	44	62.67	38	24.67	6	1
#2	70					
#3	74					

Team # 104 – Video/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	46	50	50	0	-8	0
#2	42					
#3	62					

Team # 105 – Video/Consensus Instructed

Team Member	Indiv. Score	Avg. Indiv. Score	Team Score	UARI	UBRI	Assembly Effect
#1	58	56	42	14.00	-2	0
#2	46					
#3	80					
#4	40					

APPENDIX L - VITA

VITA

Graduate School
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Bachelor of Science, Psychology, August 1993

Purdue University
Master of Science in Human Resource Management, May 1996

Special Honors and Awards:
- President Omicron Tau Theta Doctoral Honor Society (2004-2005)
- Pi Omega Pi National Honor Society (2004 – Present)
- Delta Phi Epsilon National Honor Society (2005 – Present)

Dissertation Title:
Joint Effects of Communication Mode and Consensus on Virtual Team Decision Quality

Major Professor: Dr. C. Keith Waugh

Publications:

Nasco, D. G. (2004, Spring). Mobile education on-demand: True anytime/anywhere education. *Online Journal for Workforce Education and Development, 1,* Article 02. Avaliable on the World Wide Web at, http://wed.siu.edu/Journal/volInum1/mar17003.pdf